THE
TELEGRAPHIC JOURNAL.

VOL. VI. AUGUST 15, 1878. No. CXXXIII.

ERNST WERNER SIEMENS.

ERNST WERNER SIEMENS was born at Lenthe, near Hanover, on the 13th December, 1816. He is the eldest of a large family, and the names of the brothers Werner, William, Carl, and Frederick Siemens, have long been well known in England in connection with scientific and technical works. A biographical sketch of Dr. Charles William Siemens, who has become one of England's foremost scientific men, has already appeared in No. CXX. of this Journal.

In 1834, on the completion of his school education at the college in Lübeck, Werner Siemens entered the Prussian Artillery as a volunteer, and afterwards attended the Artillery and Engineers' School in Berlin. In 1838 he obtained an officer's commission

and devoted himself sedulously to the study of chemistry and physics, for which he had previously entertained a strong liking.

A patent was granted him in Prussia in 1841 for electro-gilding and silvering. In 1842 he and his brother William Siemens took out a patent for a differential regulator.

In 1844 he was appointed to the artillery workshops in Berlin, where he turned his attention earnestly to telegraphy; and in 1845 patented his dial and printing telegraph instruments, which were used later all over Germany, and were based on the self-breaking principle of the Neef's hammer.

These instruments worked synchronously, and when in circuit all stopped at the letter or type corresponding to that of the key pressed down, and a printed impression of the letter was made. The self-acting alarms that were also first constructed about this date, worked on the same principle.

These labours led to his being made member of a Commission, which was appointed in Berlin in 1846, for the introduction of electric in place of the optical telegraphs, which had been in use up to that time. As member of this Commission, Werner Siemens in the autumn of 1846 recommended gutta-percha (just then becoming known) for the insulation of underground lines. He constructed in the following year (1847) a screw press machine to cover wires with gutta-percha, made plastic by heat but without a seam. This machine, in a slightly modified form, is to this day employed in all cable factories for the same purpose.

In 1848 his military duties called him to Kiel, where, in conjunction with his brother-in-law Professor C. Himly, he laid down the first electric submarine mines. They served to protect the town of Kiel, and saved it from being bombarded by the Danish fleet.

The Prussian Government in the autumn of 1848 deputed him to lay the first great underground telegraph line from Berlin to Frankfort-on-the-Main, and in the following year another from Berlin to Cologne, Aix-la-Chapelle, and Verviers. Werner Siemens now left the army and government service, and devoted himself henceforth to scientific pursuits and the management of a telegraph factory, which he and Mr. Halske established in 1847. The firm has since then acquired a world-wide reputation, and is indissolubly connected with the growth and progress of telegraphy. During the laying of the first underground lines Werner Siemens had observed the then remarkable phenomenon of electro-static induction, which exercised so retarding an action in the working of those lines. He described the phenomena in a paper communicated to the Paris Academy of Sciences in the year 1850. In this paper he set forth the results of this induction, as shown in the retardation of the current, and likewise gave methods for the determination of the position of faults in the insulation by means of current measurements.

From this period an almost uninterrupted series of scientific and technical discoveries and inventions emanated from him and from the factory under his direction. The most notable works and papers are the following :—

In October, 1845, a machine for the measurement of small intervals of time and the speed of electricity by means of electric sparks, and its application in 1875 for measuring the speed of the electric current in overland lines.

January, 1850, a paper on telegraph lines and apparatus, in which the theory of the electro-static charge in insulated lines, as well as methods and formulæ for the localising of faults in underground wires were first established.

In 1851, the firm erected the first automatic fire telegraphs in Berlin, and in the same year Werner Siemens wrote a treatise on the experience gained with the underground lines of the Prussian telegraph system. The difficulty of communicating through long underground lines led him to the invention of automatic translation, which was afterwards improved upon by Steinheil; and in, 1852, he furnished the Warsaw-Petersburg line with automatic fast-speed writers. The messages were punched in a paper band by means of the well known Siemens' lever-punching apparatus, and then automatically transmitted in a clockwork instrument.

In 1854, the discovery (contemporaneous with that of Frischen) of simultaneous transmission in opposite directions, and multiplex transmission by means of electro-magnetic apparatus.

In 1856, the Siemens' magneto-electric dial instrument, giving alternate currents, was constructed. From this apparatus originated the well-known Siemens' armature, and from the receiver was developed the Siemens' polarised relay, with which the working of submarine and other lines could be effected with alternate currents; and in the same year, during the laying of the Cagliari-Bona Cable, the construction and first application of dynamometers, which have become of such importance in the operations of cable laying; also development of the theory of submerging cables in deep water.

In 1857, researches on the subject of electro-static induction and the retardation of the current in insulated wires representing Leyden jars. In these researches he developed mathematically Faraday's theory of molecular induction, and thereby paved the way in great measure for its general acceptance. The construction of the ozone apparatus; also telegraph instruments with alternate currents, and translation and automatic discharge for cable lines. The Sardinia, Malta, and Corfu Cable was in the same year worked with such instruments.

In 1859, the construction of an electrical log; the discovery of the heating of the dielectric by induction; the introduction of a reproducible standard resistance measurer (Siemens' Unit); the construction of resistance bobbins and the testing of insulated wires by systematic methods were also effected by him; also researches on the influence of heat on the electrical resistance of metals, and the establishing of methods and formulæ for testing resistances, and for the determination of faults by means of resistance measurements instead of with current measurements as formerly used. These methods were adopted by the electricians to the Government, Messrs. Siemens Bros., London, during the manufacture of the Malta Alexandria Cable, which was the first long cable subjected to a system of continuous tests. The same system with improved apparatus is still employed for the testing of submarine cables.

In 1861, he showed that the electrical resistance of molten alloys is equal to the sum of the resistances

of the separate metals, and that latent heat increases the specific resistance of metals in a greater degree than free heat.

In 1864, researches on the heating of the sides of a Leyden jar by the electrical discharge.

In 1866, the establishing of the theoretical principle of Dynamo-electric machines, which led to the construction of Dynamo-electric mine exploders and light apparatus.

In 1874, a treatise on the theory of the laying and testing of submarine cables.

In May, 1875, researches on the influence of light on crystalline selenium; and in 1876 and 1877 on the change of conducting power of selenium by heat and light.

In 1878, some papers on telephony.

Werner Siemens' scientific knowledge and inventive genius combined with the great mechanical ability of his partner, Mr. Halske, soon developed the telegraph works of Siemens and Halske in Berlin into a large establishment, from which Mr. Halske retired in 1867. This development was also, to a great extent, owing to the circumstance that the firm produced a number of eminent engineers, who have for the most part remained in their service. Many instruments and new constructions are due to these engineers, whose exertions have largely contributed to the fact that the constructions of the firm are generally recognised and accepted as models. In 1865, Werner Siemens introduced pneumatic despatch tubes into Berlin; the system adopted there served as a model for that laid down in London by Siemens Bros. in 1871. The railway signalling and block system of Siemens and Halske, which has been adopted by many Continental railways, was the first to ensure a forced dependence between the electric and semaphore signals and the position of the points; the automatic cylinder transmitter, with which Morse signals are transmitted from a key board and registered automatically; an automatic fast speed printer, electric lamps, &c., are further evidence of the inventiveness of the firm.

The alcoholometer ranks as one of the most ingenious of Werner Siemens' constructions. This apparatus registers with perfect accuracy the actual quantity of absolute alcohol contained in the spirit, which is passed through it. In Russia it is adopted to facilitate the levying of the excise taxes on spirit, and many thousands of them have been manufactured at special works at Charlottenburg, near Berlin.

About 1,000 workmen are employed at the Berlin telegraph and cable works, in the latter of which the underground Cables between Berlin, Hamburg, and Kiel, and also the Strasburg-Frankfort and Hamburg Cuxhaven cables, have lately been made. The firm have also a porcelain factory in Russia for the manufacture of insulators. In all the international exhibitions, Siemens and Halske obtained the highest awards for their apparatus. They were also among the first to construct telegraph lines in Germany, and other countries. In 1854 a branch firm was established at St. Petersburg, under the direction of Carl Siemens, who became a partner. A complete network of Government telegraph lines for Russia was constructed and erected by this firm, in whose hands the technical supervision of the lines remained for twelve years. In the year 1857 a branch of the firm was established in London, and directed from the beginning by C. W. Siemens. This branch, at a later period, took the name of Siemens Bros., and has, in connection with the Berlin House, carried out a series of important works, among which may be mentioned the construction of the Indo-European line, and the manufacture, as well as laying, of the Direct United States Cable. Carl Siemens came to London after having organized the copper mines and petroleum works which the firm possess in the Caucasus. For his scientific labours, Werner Siemens had in the year 1860 the degree of Doctor (*honoris causa*) of the Berlin University conferred upon him, and in the year 1873, he was elected member of the Berlin Royal Academy of Sciences. He was for a long time member of the Prussian Parliament, and is Vice-President of the Society for the Advancement of Industry in Berlin; member of the Asiatic Society in Calcutta; Hon. Secretary for Germany of the London Society of Telegraph Engineers, &c., &c.

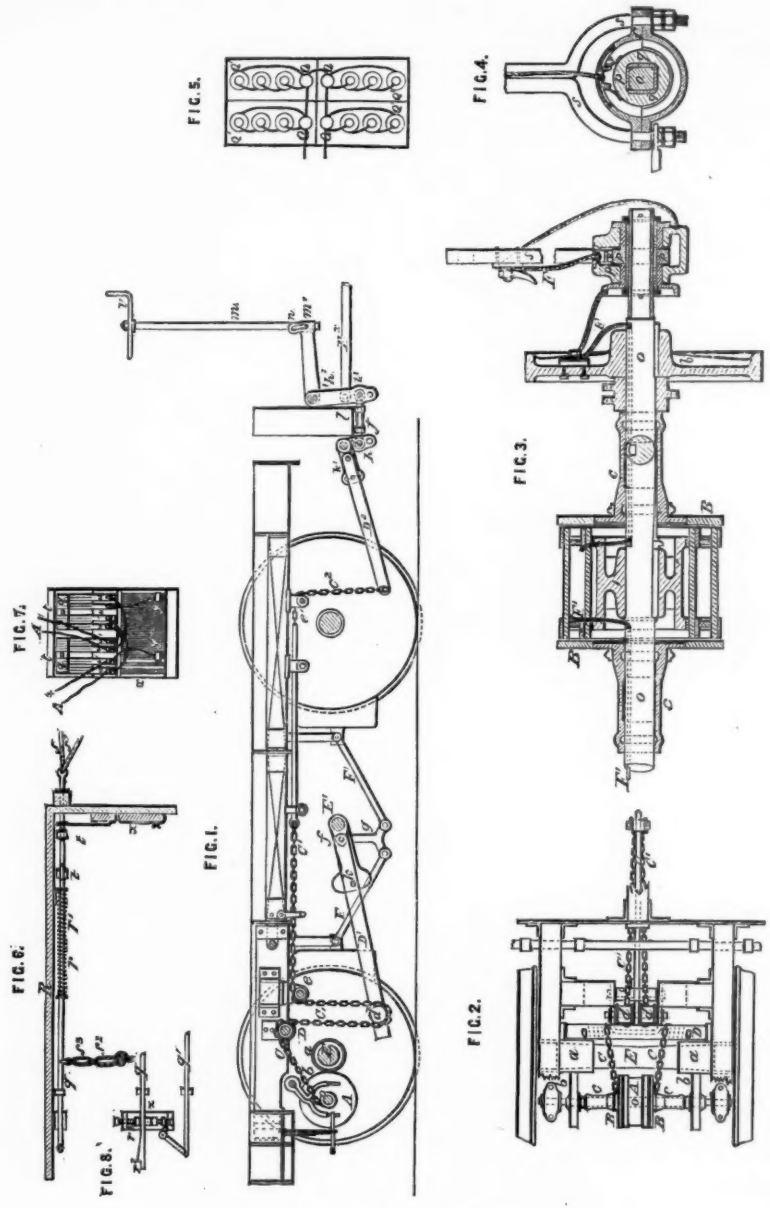
Not the least important of his many labours was the obtaining for Germany a practical patent law, after agitating this subject for a number of years, in connection with the society for Patent Protection, which he founded, and of which he was appointed permanent president.

ACHARD'S ELECTRIC APPARATUS FOR ACTUATING RAILWAY BRAKES.

THE great importance of an efficient system of railway brakes is now fully recognised, and many and ingenious are the devices which have been invented for effecting the object in view.

A point of special importance in brakes is that their action should be as instantaneous as possible. An electrical arrangement would seem to be one eminently fitted for effecting this instantaneously, and, therefore, likely to prove effectual in practice. M. Achard has given very considerable attention to the subject of electrical brakes, and his inventions are therefore worthy of record. In the different arrangements which M. Achard has designed, the brake lever is lifted by one or several chains, the winding of which is effected on a shaft or a sleeve receiving a rotary movement of the axle of the vehicle, through the intermediation of an engaging apparatus. The parts which serve for putting the brake in action, therefore, serve to effect at the proper moment the engagement of an axle which turns continuously with the shaft or sleeve of the chains. It is this mode of engagement which forms the common characteristic feature of his invention.

Fig. 1 is a longitudinal section of the frame of a tender provided with the electric brake, the electro-magnet actuating simultaneously both the break of the tender and that of the locomotive; fig. 2 is a plan of a portion of fig. 1. On the rear axle E, of the tender, sleeves or collars *a*, are keyed, which drive by friction the pulleys *b*, fixed on the shaft O, of the 4-pole electro-magnet A. Opposite each of the two faces of the magnet are arranged, at a slight distance, the plates B, B, which form the armatures; these plates carry sleeves *c*, *c*, in which the shaft O, of the



ACHARD'S ELECTRIC APPARATUS.

magnet turns freely. Chains C, C are, on the one hand, fixed to these sleeves near the plates B, and, on the other hand, wound in spirals on a drum D, situated at the upper part of the frame. To this drum are fixed the ends of the chains C^1, which descend vertically, pass round the rollers *d*, and extend to *e*. In cases where the electric brake is applied to one carriage or a tender only, that is to say, when the magnet commands the brake of only one vehicle, the chains C^1, terminate at *e* in a fixed point. The rollers *d*, are situated at the end of the lever D^1, which, pivoting around the axis E^1, lift, through the intermediation of the pin *f* and lever *g*, the brake rods F, and produce the "brakeing" of the wheels by the blocks. When the magnet has to work both the break of the tender and that of the engine, as is seen in fig. 1, the chains C^1, pass over a roller *e*, then finally lead to a rod supported by rollers, and at the end of which is fixed the chain C^2. This chain, which commands the brake of the engine, passes over a roller e^1, then descends, and is fixed to the lever D^2. This lever actuates the lever *h*, which, oscillating around the axis *i*, communicates motion to the lever h^1 through the intermediation of the connecting rod *j*. Lastly, to the lever h^1 is connected the rod E^2, which acts directly on the brake shaft of the engine. This part of the brake is not shown in the drawing.

When the magnet A acts, and causes the winding of the chains C, these lift at once the two levers D^1, D^2, and consequently produce the simultaneous application of the tender and the engine brakes. The sleeves *c*, *c*, of the plates B, B, should be longer when they work the brake of a single vehicle, as they have to wind part of the chain C^1 and the chain C^2. However, the rotation of the magnet is so rapid that the brakeing of the wheels of the tender and engine is effected quite as instantaneously.

In order to release the brakes, the electric current is interrupted, and a reverse current sent. The armatures are pushed back, and at once become loose, the chains unwind, the large levers fall, and the brake blocks separate from the wheels. To facilitate the release of the brakes, the chains C, are made a little oblique, as seen in the plan, fig. 2, in relation to the plates B, B. The winding of these chains on the drum D, is such that this obliquity is preserved, whatever be the amount of chain wound.

The intermediate levers between the large lever D^2 and the rod E^2 take their point of support on the rear cross beam of the engine frames. This is important for the following reason:—When the train is in motion the rear beam of the engine and the front one of the tender separate a little, owing to the play allowed by coupling. Now, the lever D^2, the rod E^2, and the parts of the brake of the engine, could not allow of this separation if they were fixed on the cross beam of the tender. While being jointed to the cross beam of the engine there is only a slight deviation of the chain C^2, a deviation which does not prevent the working of the apparatus.

The regulation of the brakes, according to the state of wear of the blocks, is made by the pins *k* and k^1 of the levers D^1, D^2, and by the displacement of the axes *i*, i^1, by means of double-threaded nuts *l*.

The working of the brake of the locomotive, independently of the electric apparatus, can be effected by a hand wheel *v*, provided with a threaded rod *m*. This rod carries a pin m^1, which actuates the end of the lever h^1; the groove *n*, of this lever is to permit of the action of the electric brake when the wheel *v* and its rod remain fixed.

The way in which the electric current is established and transmitted to the electro-magnet of each vehicle is as follows:—

In the front and rear vans a pile and a commutator are placed; this arrangement is necessary to avoid the breaking up and re-making of the train at each end of the line for the up and down journeys. Each pole of the pile is in communication with a wire which extends from the tender to the rear van at each side of the train, passing under the frames. A current is thus established at each side of every carriage of the train to each of the two wires, for every carriage, and for the tender a special wire is connected in communication with the 4-pole electro-magnet. The arrangement devised for passing the electric current into the electro-magnet, as well as the mode of supporting the shaft of this magnet will be fully understood on reference to figs. 3 and 4, which represent on a larger scale respectively a longitudinal section through the shaft of the magnet, and a transverse section through one of the supports of this shaft. The magnet shaft O, is square at the end to receive a bronze bearing *p*, keyed by the wedges *q*, of hard wood forcibly driven in. The bearing turns in a cast-iron plummer block P, fixed to the support S. *b* represents a friction-pulley keyed on the shaft O. The 4-pole magnet is shewn in section as well as its armatures B, and their sleeves *c*, loose on the shaft O. F is a wire connected to one of the wires of the general circuit; it leads to the plummer block P, above and below near the oil reservoir. The current passes by the springs *r*, to the bearing *p*, which the wood wedges insulate; then finally reaches the electro-magnet, following a wire fixed first to the pulley *b*, and which afterwards follows a longitudinal groove of the shaft O.

A wire F^1, connected to the second wire of the general circuit, leads to the other side of the magnet. The pile arranged in each van is a strengthened pile of the "Planté" system. It is formed of four elements, each arranged in a special case, as seen in fig. 5. Each of these elements comprises a Planté pile Q, formed of two discs of lead in spiral form, dipped in a bath of sulphuric acid; these discs communicate on the one hand with the poles of three elements of the Daniell pile Q^1, connected in tension. During work, the current of the Daniell piles produces the superficial oxidation of the lead discs, and peroxide of lead is formed. These latter communicate on the other hand with the wires which make the turn of the train, that is to say, which are in communication with the electro-magnets; when it is wished to apply the brakes, the circuit of the Planté pile is closed, peroxide of lead is decomposed, and the decomposed water is recomposed; the lead is regenerated; there is thus developed an electric current of very great intensity, to which is further added that of the Daniell piles. Under these circumstances the Planté piles play a part analogous to that of Leyden jars in static electricity; they constitute real accumulators. The peroxide of lead, which is formed between the stations under the action of the current from the Daniell piles, is decomposed at the moment of actuating the brakes, producing a very powerful electric current.

It is by combining this strengthened pile that the stoppage of a whole train in a very short distance can be caused, and at the relatively small cost which the maintenance of 12 elements of a Daniell pile requires.

The arrangement of the commutator which is employed to produce instantaneously on the one hand the sending of an electric current into the 4-pole electro-magnet, and on the other hand the cessation of this current, and the sending of a reverse current, which destroys the existing current and separates the armatures from the magnets, is as follows :—The commutator is represented in side view in fig. 6, and in end view in fig. 7. It is fixed to the platform R, of the van. It is composed of two rods q, q^1, to which are attached cords s, s^1, which lead to the engine to the hand of the driver. The cords s^2, s^3, allow in like manner the guard of the train to actuate these rods. Each of them carries two metal bars t, insulated by wooden boards, and intended to put each pole of the pile in communication with the poles of the electro-magnets by the train wires. For this purpose, by producing a traction on these rods q, q^1, the metal bars t, come in contact with metal contacts u, u^1, communicating, some with the pile, and the others with the electro-magnets. The sign, +, indicates on the drawing the contacts which communicate with the positive pole of the pile; the sign, —, those which communicate with the electro-magnets. The direction of the wires will be sufficiently understood by the drawings. The rod q, serves to transmit the current, and by working the rod q^1, a current, the reverse of the preceding, is sent to the electro-magnets, as the arrangement of the wires shows. It may be remarked that the springs r, r^1, which surround the rods q, q^1, constantly disengage the bars t from the contacts u. But, on the other hand, when the cord s or s^2 is pulled violently, the rod q is put in action to send a current. This rod is kept alone in contact with the corresponding contacts, and therefore the electric current circulates so long as the opposite rod q^1, is not acted upon to produce a current the reverse of the preceding. But also the putting in action of this last rod q^1, instantaneously produces the separation of the rod q, by the spring r, and consequently the interruption of the existing direct current. Thus, then, the direct current lasts for a certain time, the rod q, maintaining it alone, and closing the circuit so long as the rod q^1, is not pulled; then the direct current ceases, and a reverse current passes. This latter is of very short duration, the rod q^1, not maintaining it alone. Further, it should be less intense than the direct current, to prevent a winding of the chains, which would again cause the brakes to be applied. For this purpose the resistance of the wire corresponding to the positive pole of the pile in its passage from the contact u, +, to the contact u^1, +, is increased; this additional resistance is obtained by means of an iron wire x, rolled around a board. The contacts, u, +, and u^1, +, communicate with metal plates y, screwed on the board in contact with the iron wire; by varying the distance of these plates y, the intensity of the resistance is varied, and consequently that of the reverse current.

In order to carry out the above described action of the rods q, q^1, the following arrangement, shown by fig. 8, has been devised. This fig. is a portion of the commutator in plan, the platform R, being supposed removed.

The rod q, has at its end an inclined part forming a catch r^2; this inclined part passes through a guide z, which pushes against a small spring r^3. When the rod q, is pulled, the inclined part pushes aside the guide z, and when this has been passed the spring r^3 acts and retains the bar by its catch r^2. If in this situation the second rod q^1 be pulled the piece which is jointed to its end pushes the guide z, and allows the rod q to return.

M. Achard has also devised an arrangement of his brake to be used where it is desired to prevent the continuous rotation of the shaft of the electro-magnet through the axle, as in the plan just described.

SOME ELECTRICAL EXPERIMENTS WITH CRYSTALLINE SELENIUM.

BY ROBERT SABINE.

(*Continued from page* 316.)

Resistance altering with strength of Current.—Professor W. G. Adams has pointed out that when the battery power is increased the apparent resistance of the selenium is diminished. In some of the specimens of selenium which were tested, it was found that while the current was weak, up to a certain limit, the resistance *increased* in one direction and *decreased* in the other direction; but after passing the limit in question, the resistance *decreased* in both directions for any further increase of current.

One plate of selenium, annealed at 200° C., was kept at a constant temperature, and measured in a Wheatstone bridge, the proportional resistances of which were respectively 1000 and 100,000 ohms. The selenium was inverted each time by a commutator, so that measurements were repeated in both directions, whilst the currents in the bridge resistances always went in the same direction.

Current in selenium.	Measured resistance.	
	Current direct.	Current inverted.
microwebers.	megohm.	megohm.
2	·4107	·4093
4	·4119	·4080
6	·4128	·4072
8	·4131	·4063
10	·4133	·4056
12	·4133	·4050
14	·4133	·4047
20	·4130	·4038
30	·4126	·4023

A like result was found with a second plate, the resistance of which was smaller.

In each case it was found that the resistance of the selenium had somewhat increased during the measurement, due probably to heat generated by the current.

The behaviour of the selenium in these experiments is open to one of two interpretations. If due to resistance, the alteration is possibly a consequence of the cooling and heating effects of the

junctions, as was observed by Peltier between antimony and bismuth; if due to electromotive force, it is probably a simple consequence of electrolytic polarization.

It was found that when the current was reversed, two or three minutes were required to arrive at the settled value corresponding to the new conditions. This difference was small but distinct, and would be such as would correspond with change from heat to cold, or *vice versa*.

On removing the battery and inserting a galvanometer, the discharge current which issues from the selenium is in the opposite direction to the battery current, and agrees with the thermo-electric current which would result from the Peltier effect.

On the other hand, the supposition that the behaviour is due to polarization is the more probable. The increase of the resistance with increasing current (when weak) in one direction, indicates the existence in the selenium of a small independent electromotive force, and leads to the suspicion that a portion of the material in contact with one of the platinum electrodes is in an electrolytic condition, or both perhaps, one being more so than the other. As the measuring current increases in strength, it appears to polarize the electrodes in the selenium, as in an ordinary electrolytic conductor, and the small independent current is overpowered and lost sight of. The apparent decrement of resistance by increasing the battery, is probably due to the fact that the polarization increases in a less ratio than the measuring current, so that when this current is weak the polarization is proportionally stronger, and the apparent resistance higher, than when the measuring current is strong. The discharge after removing the battery is such as would answer to the depolarization of an electrolyte.

Electromotive force of Crystalline Selenium.—The action of light in modifying the conductivity of selenium is evidently a surface action, the effect of which penetrates very little, if at all, into the mass. It therefore occurred to the author that the phenomenon could best be studied, particularly in relation to heat, by making up the selenium plate in the form of a galvanic element. By this means we can deal with the surface without reference to the interior, both as regards light and heat.

A plate of crystalline selenium was prepared at 200° C. with a platinum wire fused into it, by which it was suspended in a test-tube. The back of the plate and the platinum wire near it were covered with a black insulating varnish. The tube was then placed in a light-tight box, in which a shutter could be opened to admit light to the uncovered face of the selenium. A pole of platinum foil was placed in the tube, and distilled water sufficient to nearly cover the selenium plate. This selenium (galvanic) element, when in the dark, gave an electromotive force of 0·112 volt, the selenium being positive to the platinum. On admitting diffused daylight, the direction of the current was changed, the selenium becoming negative to the platinum, with an electromotive force of 0·056 volt; so that by the admission of diffused daylight the selenium surface had become very much less electropositive than it was in the dark.

Two similar plates of selenium were prepared and placed side by side in a suitable cell, which was enclosed in a light-tight case with two shutters, by means of which light could be admitted to one or the other of the plates at pleasure. Distilled water being poured into the bottom of the cell, so as to reach about three-fourths up each plate, the electromotive force between them was measured with an accumulator, discharge-key, and galvanometer.

Both plates in the dark gave a very slight current. Then light was admitted by one of the shutters being opened. The plate on which the light fell instantly became electronegative. The consecutive readings were :—

−0·05 volt.
−0·04 „
−0·03 „

Then that shutter was closed, and, after a few minutes, the other opened. The readings were now :—

+0·09 volt
+0·08 „
+0·07 „

On connecting a galvanometer direct between the poles and observing the deflection, it was found that the current immediately following each reversal was higher, and that it subsided to a lower reading in a short time. This was probably due to polarization of the plates, and is exactly what might be expected.

(To be continued.)

AN ELECTRICAL GYROSCOPE.

THE ordinary gyroscope is an instrument too well known to require more than a brief description.

It consists essentially of a wheel, with a heavy rim, whose axis turns very freely and accurately in bearings fixed to a frame. By giving a very rapid rotatory impulse to the wheel, in virtue of its heavy rim and its freedom of rotation on its axis, this motion will be sustained for some time, and under these conditions the arrangement possesses some peculiar properties. If the frame in which the wheel turns be itself suspended in a second moveable frame, so that the axis of the wheel is perfectly free to move and be set to any position, then, under ordinary conditions, that is when the wheel is not rotated, the position of the whole arrangement relatively to any fixed objects on the earth's surface will, of course, remain constant. If, however, the wheel have a rapid rotatory impulse given it, then if the axis of the wheel be pointed at any fixed object external to the earth—a fixed star for instance—the axis will continue to point in that direction, although the base of the instrument in which the frames turn be moved about to any position. The effect of gravity in tending to keep the wheel in a fixed position relative to the earth's surface, is in fact annihilated.

The utility of this instrument in showing the rotation of the earth is obvious, for, as the earth revolves, and the base of the instrument with it, the position of the rotatory wheel with reference to the objects on the earth's surface will alter, and the amount of the displacement will be proportional to the rate of the earth's rotation. Thus, if the axes were set normal to the earth's surface, an index hand fixed to the frame in which the wheel revolves, and pointing at right angles to the axes, would move over a divided circle attached to the

base of the instrument, with an angular velocity equal to 360° multiplied by the sine of the latitude of the locality where the instrument is placed, in 24 hours, that is, provided the suspensions of the frames turned quite free of friction, which is, of course, practically impossible ; and in consequence of this friction, the arc through which the index hand would actually turn in 24 hours would be less than the number of degrees stated ; but still the error need not be sufficient to vitiate the general result.

A most essential element in the working of the apparatus is the maintenance of the wheel in rapid rotation. However well pivotted the wheel and its axis may be, and however heavy the rim, no impulse given to the wheel will cause it to maintain its rotation for any considerable length of time. As it is absolutely necessary that any mechanism for maintaining the rotation form a part of the frame in which the wheel rotates, and be quite independent of any other parts, and moreover must not affect the balance of the frame, it is evident that any clockwork arrangement turned by a heavy weight would be inadmissible. Mr. George M. Hopkins, of the United States, America, by rotating the wheel by electro-magnetism, has overcome this maintenance of rotation difficulty, and has thereby very considerably added to the value of the instrument. In fact, as far as can be seen, in consequence of this improvement of Mr. Hopkins, the gyroscope may prove a valuable scientific instrument, and not a mere toy as it has practically hitherto been.

The ordinary gyroscope as arranged with Mr. Hopkins' improvement is shown by the fig. The wheel, whose plane of rotation is at right angles with the magnet, carries a soft iron armature, which turns very near the face of the magnet, but does not touch it. An insulated contact breaking spring is arranged to touch a small cylinder on the wheel spindle twice during each rotation of the wheel. The armature is arranged in such relation to the contact breaking spring and cylinder that, twice during each revolution, as the armature nears the magnet cores, it is attracted, but immediately the armature comes directly opposite the face of the magnets cores, the current is broken, and the acquired momentum is sufficient to carry the wheel forward until the armature is again within the influence of the magnet. In order to maintain continuity with the terminal screws on the base of the instrument, one connection is made through the metal framework, and the other by means of a wire dipping in a mercury cup.

Two or three Bunsen or bichromate cells are sufficient to maintain the rotation at the necessary velocity, and all the phenomena observable in the ordinary gyroscope can be repeated with great effect on this improved instrument.

We may observe that the rotation of the earth, although shown by the gyroscope, was first ocularly demonstrated by Foucault in 1852, by means of a pendulum, as it was noticed that the plane of oscillation of the latter remained fixed like the axis of the gyroscope. Like the gyroscope, it is essential that the movements of the pendulum be perfectly free, and to effect this Foucault formed his pendulum of a heavy ball, suspended by a long thin wire. Such an arrangement, although it answered the purpose of keeping up the oscillatory movement for several hours, is manifestly not one adapted for general purposes. The late Sir Charles Wheatstone devised an ingenious electrical arrangement by means of which the movements of a short pendulum freely suspended could be kept up for any length of time. His arrangement was as follows :—

The bob of the pendulum was an iron ball ; this ball, when the pendulum was at rest, hung exactly over and close to the single pole of an electro-magnet, which we will call the pendulum electro-magnet. In this pole a slight cup-shaped

hollow was formed, in which a globule of mercury was placed. A needle point fixed to the lower part of the pendulum bob dipped into this globule and so formed an electrical communication between the wire, by which the bob was suspended and the iron core of the magnet; this connection was of course only made when the pendulum swung over the pole of the electro-magnet.

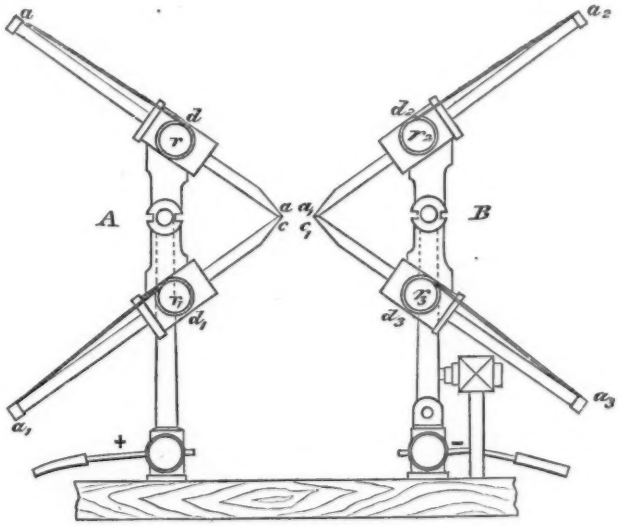
A battery kept a current flowing through this pendulum electro-magnet so long as the pendulum bob was on either side of the pole; consequently an attraction was exerted on the bob as it swung. Immediately the bob came over the pole of the magnet, and communication was set up through the globule of mercury, a current from a local battery flowed through a local electro-magnet through the medium of the iron core of the pendulum electro-magnet. The attraction of the armature of this electro-magnet broke the circuit of the pendulum electro-magnet, so that the attraction on the iron bob ceased, and the pendulum was free to swing towards the other limit of its course.

In order to prevent the circuit of the pendulum electro-magnet being completed immediately after the bob broke contact with the globule of mercury (as this would limit the arc of the swing to a very few degrees), the armature of the local electro-magnet did not make contact against a fixed contact screw, but against a slow turning fly of a train of clock-work; so that when the armature was attracted the fly was released, contact was broken, and this contact would not again be made, although the armature had been released by the pendulum bob swinging past the globule of mercury, until the fly had completely swung round and again come in contact with the armature.

RAPIEFF'S ELECTRIC LAMP.

THIS ingenious arrangement is shown by the fig.; its principle is as follows:—

Two sets of carbons a, c and a_1, c_1, which are set obliquely, meet with one another at their ends as shewn. These carbons are supported by and move longitudinally in tubes or slides d, d_1, d_2, d_3, fixed to the standards A and B. Springs or weights connected to the pulleys r, r_1, r_2, r_3 tend to press forward the carbons through the medium of cords attached to their ends a, a_1, a_2, a_3, so that the ends a, c and a_1, c_1, always remain in contact, however much they may be wasted by burning; moreover the locality of these points of contact always remains the same, and thus the distance between a, c and a_1, c_1, is always preserved constant.



By means of joints in the standards A and B the angle at which the carbons are inclined to one another can be altered if necessary. The distance between the two sets of points can be varied by sliding one of the stands forward or backwards.

In cases where sub-division of light is required, and several lamps have to be put in one and the same circuit, it is absolutely necessary that some arrangement be provided which will prevent the interruption of the circuit should one of the lamps fail and cause a disconnection. In order to effect this object, M. Rapieff provides two paths for the current to flow through at each lamp, one through the carbon points, and the other through a circuit which is interrupted the moment the current flows between the carbon points, but which is completed again should the current fail between them.

THE BRITISH ASSOCIATION.

WE hope the present number of our journal will appear in time to give those of our readers who intend to take part in the meeting of the British Association, now being held, information as to the means that have been provided for their accommodation, instruction, and recreation.

The journey to Ireland is most easy and convenient, thanks to the splendid mail-service between London and Dublin. By this route the whole journey is accomplished in less than twelve hours; by the London and North Western Company's boats the journey is quite as pleasant and much cheaper, though slightly longer. On landing, visitors will have no difficulty in finding accommodation, as, besides the generous hospitality so freely offered by Dublin residents, long lists of apartments have been prepared by the local committee, and most of the clubs have also opened their doors to members of the Association.

The proceedings of the Association begin on Wednesday, August 14th, with an evening lecture in the Exhibition Palace from Dr. Spottiswoode, the President-elect. Mr. Romane's discourse on "Animal Intelligence," and Professor Dewar's on "Dissociation; or, Modern Ideas of Chemical Action," on the evenings of August 16th and 19th, are given in the same building, which affords ample space for the numbers who are sure to attend these meetings. On Thursday the business proceedings of the week begin, the different sections meeting at eleven on that day in the various buildings assigned them in Trinity College. It is unusual to find such a convenient and central place of meeting in any town, and the fact that Dublin can find room for each section on one spot of ground should alone help to ensure the success of the present meeting. The Reception Committee have the large Examination Hall, near the entrance to Trinity College, which is also comfortably fitted up with chairs, tables, &c., for the use of members.

Thursday will prove a busy day, for, in addition to a garden-party and dinner given by the Lord-Lieutenant to the most distinguished members of the Association, a *soirée* is given in the evening by the Royal Dublin Society, for which most extensive preparations have been made, and which promises to be an entire success.

The splendid Museum will be thrown open for promenading, whilst the lawn in front will be electrically lighted. A powerful gas-engine and steam and water engines will be in action in a side hall, and amongst other exhibitions, will be an interesting display of carnivorous plants. Dr. Moss, of the Arctic expedition, has consented to discourse upon the extinct Irish deer, of which some remains were lately found near the Scalp, in the county Dublin, and will be on exhibition at the *soirée*. Members of one of the excursions will have an opportunity of seeing some of these remains *in situ*.

A phonograph has been lent by the London Stereoscopic Company, and many interesting pieces of apparatus from the South Kensington Museum, and the Loan Exhibition will also be exhibited. Amongst the electrical experiments, some with vacuum tubes are sure to prove attractive. A large induction coil, lent by Mr. Yates, and condenser of Mr. Spottiswoode's, are also included in the exhibits of this department.

Experiments will be conducted in another part of the building with the spectroscope and the polariscope, and to complete the variety of the entertainment, the Earl of Rosse has sent a beautifully fitted up telescope.

For Saturday an unusually complete and attractive list of excursions to the beautiful neighbourhood of Dublin has been published. The local papers give full programmes of these; we may just mention those to Brag Head, taking the Dargle and the Scalp on the way; to Howth and Ireland's Eye (interesting to botanists); for antiquarians, one to Malahide Castle and Swords; another by steamer to the points of interest around Dublin Bay; and finally, also by steamer, one to the lighthouses and light-ships in the Bay.

From the Howth Lighthouse, the electric light will be exhibited. Entertainment is offered to all joining these excursions by various resident noblemen.

The festivities of Monday commence with a breakfast given by the Royal Zoological Society in Phœnix Park; then, after the sectional meetings, comes a dinner at the College of Physicians, and a *conversazione* at the Royal College of Surgeons. The same evening Professor Dewar gives his lecture.

On Tuesday evening a *soirée* is given by the Royal Irish Academy, which promises to be of great interest, chiefly for the collection of ancient Irish manuscripts and remains that are contained in its museum. The oldest and most valuable manuscript is a copy, made by one of the abbots of Clonmacuoise, of a book composed in the seventh century. It is called the "Book of the Dun Cow," from the skin on which this copy was written, about the year 1100 A.D. Various other manuscripts, together with the library of the poet Moore, autograph copies of certain well-known poems, &c., are sure to interest the visitors.

The general committee meets finally on Wednesday, to select the next place of meeting, and on Thursday, again, delightful excursions are in prospect. Glendalough and the Seven Churches will attract antiquarians and lovers of beautiful scenery; but no less beautiful is the well-known Vale of Ovoca, Cashel, Kilkenny, Powerscourt, Curragh Camp, Boyne, the Varty Waterworks, and the Earl of Rosse's entertainment at Birr Castle. These excursions will surely satisfy the most exigeant of travellers. On Friday the members of the Association will have an opportunity of visiting the principal manufactories of Lisburn and Belfast. There is, thus, plenty of attraction of a non-scientific character for this week of meetings, and we anticipate a no less satisfactory scientific result. No papers of special interest are yet announced, but we may hope that to convince Englishmen of the cleverness and intellectual activity of their Irish neighbours, and to show Irishmen the real worth and desirability of scientific knowledge, will be no small achievement for the forty-eighth meeting of the British Association for the Advancement of Science and Art.

In our next we hope to give a general epitome of the meetings.

ADDRESS OF WILLIAM SPOTTISWOODE, ESQ., M.A., D.C.L., LL.D., F.R.S., F.R.A.S., F.R.G.S., PRESIDENT.

ON looking back at the long array of distinguished men who both in this and in the sister countries have filled the chair of the British Association; on considering also the increased pains which have been bestowed upon, and the increased importance attaching to, the Presidential Address; it may well happen when, as on this occasion, your choice has fallen upon one outside the sphere of professional Science, that your nominee should feel unusual diffidence in accepting the post. Two considerations have however in my own case outweighed all reasons for hesitation: First, the uniform kindness which I received at the hands of the Association throughout the eight years during which I had the honour of holding another office; and, secondly, the conviction that the same goodwill which was accorded to your Treasurer would be extended to your President.

These considerations have led me to arrange my observations under two heads, viz., I propose first to offer some remarks upon the purposes and prospects of the Association with which, through your suffrages, I have been so long and so agreeably connected; and, secondly, to indulge in a few reflexions, not indeed upon the details or technical progress, but upon the external aspects and tendencies of the Science which on this occasion I have the honour to represent. The former of these subjects is perhaps trite; but as an old man is allowed to become garrulous on his own hobby, so an old officer may be pardoned for lingering about a favourite theme. And although the latter may appear somewhat unpromising, I have decided to make it one of the topics of my discourse, from the consideration that the holder of this office will generally do better by giving utterance to what has already become part of his own thought, than by gathering matter outside of its habitual range for the special occasion. For, as it seems to me, the interest (if any) of an address consists, not so much in the multitude of things therein brought forward, as in the individuality of the mode in which they are treated.

The British Association has already entered its fifth decade. It has helds its meetings, this the 48th, in twenty-eight different towns. In six cities of note, viz., York, Bristol, Newcastle-on-Tyne, Plymouth, Manchester, and Belfast, its curve of progress may be said to have a node, or point through which it has twice passed; in the five Universities of Oxford, Cambridge, Dublin, Edinburgh, and Glasgow, and in the two great commercial centres, Liverpool and Birmingham, it may similarly be said to have a triple point, or one through which it has three times passed. Of our forty-six Presidents more than half (twenty-six, in fact) have passed away; while the remainder hold important posts in Science, and in the Public Service, or in other avocations not less honourable in themselves, nor less useful to the commonwealth. And whether it be due to the salubrity of the climate or to the calm and dispassionate spirit in which Science is pursued by its votaries here, I do not pretend to say; but it is a fact that the earliest of our ex-Presidents still living, himself one of the original members of the Association, is a native of and resident in this country.

At both of our former meetings held in Dublin, in 1835, and 1857 respectively, while greatly indebted to the liberal hospitality of the citizens at large, we were, as we now are, under especial obligations to the authorities of Trinity College for placing at our disposal buildings, not only unusually spacious and convenient in themselves, but full of reminiscences calculated to awake the scientific sympathies of all who may be gathered in them. At both of those former Dublin meetings the venerable name of Lloyd figured at our head; and if long-established custom had not seemed to preclude it, I could on many accounts have wished that we had met for a third time under the same name. And although other distinguished men, such as Dr. Robinson, Professors Stokes, Tyndall, and Andrews, are similarly disqualified by having already passed the Presidental chair, while others again, such as Sir W. R. Hamilton, Dr. M'Cullagh, and Professor Jukes, are permanently lost to our ranks; still we should not have had far to seek, had we looked for a President in this fertile island itself. But as every one connected with the place of meeting partakes of the character of host towards ourselves as guests, it has been thought by our oldest and most experienced members that we should better respond to an invitation by bringing with us a President to speak as our representative than by seeking one on the spot; and we may always hope on subsequent occasions that some of our present hosts may respond to a similar call.

But leaving our past history, which will form a theme more appropriate to our jubilee meeting in 1881, at the ancient City of York, I will ask your attention to a few particulars of our actual operations.

Time was when the Royal Societies of London and Edinburgh and the Royal Irish Academy were the only representative bodies of British Science and the only receptacles of memoirs relating thereto. But latterly the division of labour, so general in industrial life, has operated in giving rise to special societies, such as the Astronomical, the Linnæan, the Chemical, the Geological, the Geographical, the Statistical, the Mathematical, the Physical, and many others. To both the earlier, or more general, and the later or more special societies alike, the British Association shows resemblance and affinity. We are general in our comprehensiveness; we are special in our sectional arrangement; and in this respect we offer not only a counterpart, but to some extent a counterpoise, to the general tendency to sub-division in science. Further still, while maintaining in their integrity all the elements of a strictly scientific body, we also include, in our character of a microcosm, and under our more social aspect, a certain freedom of treatment, and interaction of our various branches, which is scarcely possible among separate and independent societies.

The general business of our meetings consists, first, in receiving and discussing communications upon scientific subjects at the various sections into which our body is divided, with discussions thereon; secondly, in distributing, under the advice of our Committee of Recommendations, the funds arising from the subscriptions of members and associates; and thirdly, in electing a council upon whom devolves the conduct of our affairs until the next meeting.

The communications to the sections are of two kinds, viz., papers from individuals, and reports from committees.

As to the subject-matter of the papers, nothing which falls within the range of natural knowledge, as partitioned among our sections, can be considered foreign to the purposes of the Association; and even many applications of science, when viewed in reference to their scientific bases, may properly find a place in our proceedings. So numerous, however, are the topics herein comprised, so easy the transition beyond these limits, that it has been thought necessary to confine ourselves strictly within this range, lest the introduction of other matters, however interesting to individual members, should lead to the sacrifice of more important subjects. As to the form of the communications, while it is quite true that every scientific conclusion should

be based upon substantial evidence, every theory complete before being submitted for final adoption, it is not the less desirable that even tentative conclusions and hypothetical principles when supported by sufficient *primâ facie* evidence, and enunciated in such a manner as to be clearly apprehended, should find room for discussion at our sectional meetings. Considering, however, our limitations of time, and the varied nature of our audience, it would seem not inappropriate to suspend, mentally if not materially, over the doors of our section rooms, the Frenchman's dictum, that no scientific theory "can be considered complete until it is so clear that it can be explained to the first man you meet in the street."

Among the communications to the Sections, undoubtedly the most important, as a rule, are the Reports; that is to say, documents issuing from specially appointed Committees, some of which have been recipients of the grants mentioned above. These Reports are in the main of two kinds, first, accounts of observations carried on for a series of years, and intended as records of information on the special subjects; such for instance have been those made by the Kew Committee, by the Committees on Luminous Meteors, on British Rainfall, on the Speed of Steamships, on Underground Temperature, on the Exploration of certain Geological Caverns, &c. These investigations, frequently originating in the energy and special qualifications of an individual, but conducted under the control of a Committee, have in many cases been continued from year to year, until either the object has been fully attained, or the matter has passed into the hands of other bodies, which have thus been led to recognise an inquiry into these subjects as part and parcel of their appropriate functions. The second class is one which is perhaps even more peculiar to the Association; viz., the Reports on the progress and present state of some main topics of Science. Among these may be instanced the early Reports on Astronomy, on Optics, on the Progress of Analysis; and later, those on Electrical Resistance, and on Tides; that of Prof. G. G. Stokes on Double Refraction; that of Prof. H. J. Smith on the Theory of Numbers; that of Mr. Russell on Hyperelliptic Transcendents; and others. On this head Prof. Carey Foster, in his address to the Mathematical and Physical Section at our meeting last year, made some excellent recommendations, to which, however, I need not at present more particularly refer, as the result of them will be duly laid before the section in the form of the report from a committee to whom they were referred. It will be sufficient here to add that the wide extension of the sciences in almost every branch, and the consequent specialisation of the studies of each individual, have rendered the need for such reports more than ever pressing; and if the course of true science should still run smooth, it is probable that the need will increase rather than diminish.

If time and space had permitted, I should have further particularised the committees occasionally appointed on subjects connected with education. But I must leave this theme for some future president, and content myself with pointing out that the British Association alone among scientific societies concerns itself directly with these questions, and is open to appeals for counsel and support from the great teaching body of the country.

One of the principal methods by which this Association materially promotes the advancement of science, and consequently one of its most important functions, consists in grants of money from its own income in aid of special scientific researches. The total amount so laid out during the forty-seven years of our existence has been no less than £44,000; and the average during the last ten years has been £1,450 per annum. These sums have not only been in the main wisely voted and usefully expended; but they have been themselves productive of much additional voluntary expenditure of both time and money on the part of those to whom the grants have been entrusted. The results have come back to the Association in the form of papers and reports, many of which have been printed in our volumes. By this appropriation of a large portion of its funds, the Association has to some extent anticipated, nay even it may have partly inspired the ideas, now so much discussed, of the Endowment of Research. And whether the aspirations of those who advocate such endowment be ever fully realised or not, there can I think be no doubt whatever that the Association in the matter of these grants has afforded a most powerful stimulus to original research and discovery.

Regarded from another point of view these grants, together with others to be hereafter mentioned, present a strong similarity to that useful institution, the Professoriate Extraordinary of Germany, to which there are no foundations exactly corresponding in this country. For, beside their more direct educational purpose, these Professorships are intended, like our own grants, to afford to special individuals an opportunity of following out the special work for which they have previously proved themselves competent. And in this respect the British Association may be regarded as supplying to the extent of its means, an elasticity which is wanting in our own Universities.

Besides the funds which through your support are at the disposal of the British Association there are, as is well known to many here present, other funds of more or less similar character, at the disposal or subject to the recommendations of the Royal Society. There is the Donation Fund, the property of the Society; the Government Grant of £1,000 per annum, administered by the Society; and the Government Fund of £4,000 per annum (an experiment for five years) to be distributed by the Science and Art Department, both for research itself, and for the support of those engaged thereon, according to the recommendations of a Committee consisting mainly of Fellows of the Royal Society. To these might be added other funds in the hands of different Scientific Societies.

But although it must be admitted that the purposes of these various funds are not to be distinguished by any very simple line of demarcation, and that they may therefore occasionally appear to overlap one another, it may still, I think be fairly maintained that this fact does not furnish any sufficient reason against their co-existence. There are many topics of research too minute in their range, too tentative in their present condition, to come fairly within the scope of the funds administered by the Royal Society. There are others, ample enough in their necessary duration, to claim for their support a national grant, but which need to be actually set on foot or tried before they can fairly expect the recognition either of the public or of the Government. To these categories others might be added; but the above-mentioned instances will perhaps suffice to show that even if larger and more permanent funds were devoted to the promotion of research than is the case at present, there would still be a field of activity open to the British Association as well as to other scientific bodies which may have funds at their disposal.

On the general question it is not difficult to offer strong arguments in favour of permanent national Scientific Institutions; nor is it difficult to picture to the mind an ideal future when Science and Art shall walk hand in hand together, led by a willing minister into the green pastures of the Endowment of Research. But while allowing this to be no impossible a future,

we must still admit that there are other and less promising possibilities, which under existing circumstances cannot be altogether be left out of our calculations. I am therefore on the whole inclined to think that, while not losing sight of larger schemes, the wisest policy, for the present at all events, and pending the experiment of the Government fund, will be to confine our efforts to a careful selection of definite persons to carry out definite pieces of work; leaving to them the honour (or the onus if they so think it) of justifying from time to time a continuation of the confidence which the Government or other supporting body may have once placed in them.

Passing from the proceedings to other features and functions of our body, it should be remembered that the continued existence of the Association must depend largely upon the support which it receives from its members and associates. Stinted in the funds so arising, its scientific effectiveness would be materially impaired; and deprived of them, its existence would be precarious. The amount at our disposal in each year will naturally vary with the population, with the accessibility, and with other circumstances of the place of meeting; there will be financially, as well as scientifically, good years and bad years. But we have in our invested capital a sum sufficient to tide over all probable fluctuations, and even to carry us efficiently through several years of financial famine, if ever such should occur. This seems to me sufficient; and we have therefore, I think, no need to increase our reserve, beyond perhaps the moderate addition which a prudent treasurer will always try to secure, against expenditure which often increases and rarely diminishes.

But however important this material support may be to our existence and well being, it is by no means all that is required. There is another factor which enters into the product, namely, the personal scientific support of our best men. It is, I think, not too much to say, that without their presence our meetings would fail in their chief and most important element, and had best be discontinued altogether. We make, it must be admitted, a demand of sensible magnitude in calling upon men who have been actively engaged during a great portion of the year, at a season when they may fairly look for relaxation, to attend a busy meeting, and to contribute to its proceedings; but unless a fair quota at least of our veterans, and a good muster of our younger men, put in their appearance, our gatherings will be to little purpose. There was a period within my own recollection when it was uncertain whether the then younger members of our scientific growth would cast in their lot with us or not, and when the fate of the Association depended very much upon their decision. They decided in our favour; they have since become Presidents, Lecturers, and other functionaries of our body; with what result it is for you to judge.

Of the advantages which may possibly accrue to the locality in which our meetings are held, it is not for us to speak; but it is always a ground for sincere satisfaction to learn that our presence has been of any use in stimulating an interest, or in promoting local efforts, in the direction of Science.

The functions of the British Association do not, however, terminate with the meeting itself. Beside the special committees already mentioned, there remains a very important body, elected by the General Committee, viz., the Council, which assembles at the office in London from time to time as occasion requires. To this body belongs the duty of proposing a President, of preparing for the approval of the General Committee the list of Vice-Presidents and sectional officers, the selection of evening lecturers, and other arrangements for the coming meeting.

At the present time another class of questions occupies a good deal of the attention of the Council. In the first generation of the Association, and during the period of unwritten, but not yet traditional, law, questions relating to our own organisation or procedure either "settled themselves," or were wisely left to the discretionary powers of those who had taken part in our proceedings during the early years of our existence. These and other kindred subjects now require more careful formularisation and more deliberate sanction. And it is on the shoulders of the Council that the weight of these matters in general falls. These facts deserve especial mention on the present occasion, because one part of our business at the close of this meeting will be to bid farewell officially to one who has served us as Assistant Secretary so long and so assiduously that he has latterly become our main repertory of information, and our mentor upon questions of precedent and procedure. The post hitherto held by Mr. Griffith (for it is to him that I allude) will doubtless be well filled by the able and energetic member who has been nominated in his place; but I doubt that even he will be glad for some time to come to draw largely upon the knowledge and experience of his predecessor.

But, beside matters of internal arrangement and organisation, the duties of the Council comprise a variety of scientific subjects referred to them by the General Committees, at the instance of the Committee of Recommendations, for deliberation and occasionally for action. With the increasing activity of our body in general, and more particularly with that of our various officers, these duties have of late years become more varied and onerous than formerly; nor is it to be wished that they should diminish in either variety or extent.

Once more, questions beyond our own constitution, and even beyond the scope of our own immediate action, such as education, legislation affecting either the promotion or the applications of science to industrial and social life, which have suggested themselves at our meetings, and received the preliminary sanction of our Committee of cf Recommendations, are frequently referred to our Council. These, and others which it is unnecessary to particularise, whether discussed in full Council or in committees specially appointed by that body, render the duties of our councillors as onerous as they are important.

While the Government has at all times, but in a more marked manner of late years, recognised the Royal Society of London, with representatives from the sister societies of Dublin and of Edinburgh, as the body to which it should look for counsel and advice upon scientific questions, it has still never shown itself indisposed to receive and entertain any well-considered recommendation from the British Association. Two special causes have in all probability contributed largely to this result. First, the variety of elements comprised by the Association, on account of which its recommendations imply a more general concurrence of scientific opinion than those of any other scientific body. Secondly, the peculiar fact, that our period of maximum activity coincides with that of minimum activity of other scientific bodies, is often of the highest importance. At the very time when the other bodies are least able, we are most able, to give deliberate consideration, and formal sanction, to recommendations whether in the form of applications to Government or otherwise which may arise. In many of these, time is an element so essential, that it is not too much to say, that without the intervention of the British Association many opportunities for the advancement of Science, especially at the seasons in question, might have been lost. The Government has moreover formally recognised our scientific existence by appointing our President for the time being a member of the Government Fund Committee; and the public has added its

testimony to our importance and utility by imposing upon our President and officers a variety of duties, among which are conspicuous those which arise out of its very liberal exercise of civic and other hospitality.

Of the nature and functions of the Presidential address this is perhaps neither the time nor the place to speak; but if I might for a moment forget the purpose for which we are now assembled, I would take the opportunity of reminding those who have not attended many of our former meetings that our annual volumes contain a long series of addresses on the progress of Science, from a number of our most eminent men, to which there is perhaps no parallel elsewhere. These addresses are perhaps as remarkable for their variety in mode of treatment as for the value of their subject-matter. Some of our Presidents, and especially those who officiated in the earlier days of our existence, have passed in review the various branches of Science, and have noted the progress made in each during the current year. But, as the various Sciences have demanded more and more special treatment on the part of those who seriously pursue them, so have the cases of individuals who can of their own knowledge give anything approaching to a general review become more and more rare. To this may be added the fact that although no year is so barren as to fail in affording sufficient crop for a strictly scientific budget, or for a detailed report of progress in research, yet one year is more fertile than another in growths of sufficient prominence to arrest the attention of the general public, and to supply topics suitable for the address. On these accounts apparently such a Presidential survey has ceased to be annual, and has dropped into an intermittence of longer period. Some Presidents have made a scientific principle, such as the Time-element in natural phenomena, or Continuity, or Natural Selection, the theme of their discourse, and have gathered illustrations from various branches of knowledge. Others again, taking their own special subject as a fundamental note, and thence modulating into other kindred keys, have borne testimony to the fact that no subject is so special as to be devoid of bearing or of influence on many others. Some have described the successive stages of even a single but important investigation; and while tracing the growth of that particular item, and of the ideas involved in it, have incidentally shown to the outer world what manner of business a serious investigation is. But there is happily no pattern or precedent which the President is bound to follow; both in range of subject-matter and in mode of treatment each has exercised his undoubted right of taking an independent line. And it can hardly be doubted that a judicious exercise of this freedom has contributed more than anything else to sustain the interest of a series of annual discourses extending now over nearly half a century.

The nature of the subjects which may fairly come within the scope of such a discourse has of late been much discussed; and the question is one upon which everyone of course is entitled to form his own judgment; but lest there should be any misapprehension as to how far it concerns us in our corporate capacity, it will be well to remind my hearers that as, on the one hand, there is no discussion on the Presidential address, and the members as a body express no formal opinion upon it, so, on the other, the Association cannot fairly be considered as in any way committed to its tenour or conclusions. Whether this immunity from comment and reply be really on the whole so advantageous to the President as might be supposed need not here be discussed; but suffice it to say that the case of an audience assembled to listen without discussion finds a parallel elsewhere, and in the parallel case it is not generally considered that the result is altogether either advantageous to the speaker or conducive to excellence in the discourse.

But, apart from this, the question of a limitation of range in the subject-matter for the Presidental address is not quite so simple as may at first sight appear. It must, in fact, be born in mind that, while on the one hand knowledge is distinct from opinion, from feeling, and from all other modes of suggestive impression, still the limits of knowledge are at all times expanding, and the boundaries of the known and the unknown are never rigid or permanently fixed. That which in time past or present has be longed to one category may in time future belong to the other. Our ignorance consists partly in ignorance of actual facts, and partly also in ignorance of the possible range of ascertainable fact. If we could lay down beforehand precise limits of possible knowledge, the problem of Physical Science would be already half solved. But the question to which the scientific explorer has often to address himself is not merely whether he is able to solve this or that problem, but whether he can so far unravel the tangled threads of the matter with which he has to deal as to weave them into a definite problem at all. He is not like a candidate at an examination with a precise set of questions placed before him; he must first himself act the part of the examiner and select questions from the repertory of nature, and upon them found others, which in some sense are capable of definite solution. If his eyes seem dim, he must look steadfastly and with hope into the misty vision, until the very clouds wreath themselves into definite forms. If his ear seem dull, he must listen patiently and with sympathetic trust to the intricate whisperings of nature—the goddess, as she has been called, of a hundred voices—until here and there he can pick out a few simple notes to which his own powers can resound. If, then, at a moment when he finds himself placed on a pinnacle from which he is called upon to take a perspective survey of the range of science, and to tell us what he can see from his vantage ground; if, at such a moment, after straining his gaze to the very verge of the horizon, and after describing the more distant of well-defined objects, he should give utterance also to some of the subjective impressions which he is conscious of receiving from regions beyond; if he should depict possibilities which seem opening to his view; if he should explain why he thinks this a mere blind alley and that an open path; then the fault and the loss would be alike ours if we refused to listen calmly, and temperately to form our own judgment on what we hear; then assuredly it is we who would be committing the error of confounding matters of fact and matters of opinion if we failed to discriminate between the various elements contained in such a discourse, and assumed that they had all been put on the same footing.

But to whatever decision we may each come on these controverted points, one thing appears clear from a retrospect of past experience, viz., that first or last, either at the ouset in his choice of subject or in the conclusions ultimately drawn therefrom, the President, according to his own account at least, finds himself on every occcasion in a position of "exceptional or more than usual difficulty." And your present representative, like his predecessors, feels himself this moment in a similar predicament. The reason which he now offers is that the branch of science which he represents is one whose lines of advance, viewed from a mathematician's own point of view, offer so few points of contact with the ordinary experiences of life or modes of thought, that any account of its actual progress which he might have attempted must have failed in the first requisite of an address, namely, that of being intelligible.

Now if this esoteric view had been the only aspect of the subject which he could present to his hearers, he might well have given up the attempt in despair. But although in its technical character mathematical science suffers the inconveniences, while it enjoys the dignity, of its Olympian position, still in a less formal garb, or in disguise, if you are pleased so to call it, it is found present at many an unexpected turn; and although some of us may never

have learnt its special language, not a few have, all through our scientific life, and even in almost every accurate utterance, like Moliére's well known character, been talking mathematics without knowing it. It is, moreover, a fact not to be overlooked that the appearance of isolation, so conspicuous in mathematics, appertains in a greater or less degree to all other sciences, and perhaps also to all pursuits in life. In its highest flight each soars to a distance from its fellows. Each is pursued alone for its own sake, and without reference to its connection with, or its application to, any other subject. The pioneer and the advanced guard are of necessity separated from the main body, and in this respect mathematics does not materially differ from its neighbours. And, therefore, as the solitariness of mathematics has been a frequent theme of discourse, it may be not altogether unprofitable to dwell for a short time upon the other side of the question, and to inquire whether there be not points of contact in method or in subject-matter between mathematics and the outer world which have been frequently overlooked; whether its lines do not in some cases run parallel to those of other occupations and purposes of life; and lastly, whether we may not hope for some change in the attitude too often assumed towards it by the representatives of other branches of knowledge and of mental activity.

In his Preface to the "Principia" Newton gives expression to some general ideas which may well serve as the key-note for all future utterances on the relation of mathematics to natural, including also therein what are commonly called artificial, phenomena.

"The ancients divided mechanics into two parts, rational and practical; and since artizans often work inaccurately, it came to pass that mechanics and geometry were distinguished in this way, that everything accurate was referred to geometry, and everything inaccurate to mechanics. But the inaccuracies appertain to the artizan and not to the art, and geometry itself has its foundation in mechanical practice, and is in fact nothing else than that part of universal mechanics which accurately lays down and demonstrates the art of measuring." He next explains that rational mechanics is the science of motion resulting from forces, and adds, "The whole difficulty of philosophy seems to me to lie in investigating the forces of nature from the phenomena of motion, and in demonstrating that from these forces other phenomena will ensue." Then, after stating the problems of which he has treated in the work itself, he says, "I would that all other natural phenomena might similiarly be deduced from mechanical principles. For many things move me to suspect that everything depends upon certain forces in virtue of which the particles of bodies, through forces not yet understood, are either impelled together so as to cohere in regular figures, or are repelled and recede from one another."

Newton's views, then, are clear. He regards mathematics, not as a method independent of, though applicable to, various subjects, but as itself the higher side or aspect of the subjects themselves; and it would be little more than a translation of his notions into other language, little more than a paraphrase of his own words, if we were to describe the mathematical as one aspect of the material world itself, apart from which all other aspects are but incomplete sketches, and, however accurate after their own kind, are still liable to the imperfections of the inaccurate artificer. Mr. Burrowes, in his preface to the first volume of the "Transactions of the Royal Irish Academy," has carried out the same argument approaching it from the other side. "No one science," he says, "is so little connected with the rest as not to afford many principles whose use may extend considerably beyond the science to which they primarily belong, and no proposition is so purely theoretical as to be incapable of being applied to practical purposes. There is no apparent connection between duration and the cycloidal arch, the properties of which have furnished us with the best method of measuring time; and he who has made himself master of the nature and affections of the logarithmic curve has advanced considerably towards ascertaining the proportionable density of the air at various distances from the earth. The researches of the mathematician are the only sure ground on which we can reason from experiments; and how far experimental science may assist commercial interests is evinced by the success of manufacturers in countries where the hand of the artificer has taken its direction from the philosopher. Every manufacture is in reality but a chemical process, and the machinery requisite for carrying it on but the right application of certain propositions in rational mechanics." So far your Academician. Every subject, therefore, whether in its usual acceptation, scientific, or otherwise, may have a mathematical aspect; as soon, in fact, as it becomes a matter of strict measurement, or of numerical statement, so soon does it enter upon a mathematical phase. This phase may, or it may not, be a prelude to another in which the laws of the subject are expressed in algebraical formulæ or represented by geometrical figures. But the real gist of the business does not always lie in the mode of expression, and the fascination of the formulæ or other mathematical paraphernalia may, after all, be a little more than that of a theatrical transformation scene. The process of reducing to formulæ is really one of abstraction, the results of which are not always wholly on the side of gain; in fact, through the process itself the subject may loose in one respect even more than it gains in another. But long before such abstraction is completely attained, and even in cases where it is never attained at all, a subject may to all intents and purposes become mathematical. It is not so much elaborate calculations or abstruse processes which characterise this phrase as the principles of precision, of exactness, and of proportion. But these are principles with which no true knowledge can entirely dispense. If it be the general scientific spirit which at the outset moves upon the face of the waters, and out of the unknown depth brings forth light and living forms, it is no less the mathematical spirit which breathes the breath of life into what would otherwise have ever remained dry bones of fact, which reunites the scattered limbs and re-creates from them a new and organic whole.

And as a matter of fact, in the words used by Professor Jellett at our meeting at Belfast, viz., "Not only are we applying our methods to many sciences already recognised as belonging to the legitimate province of mathematics, but we are learning to apply the same instrument to sciences hitherto wholly or partially independent of its authority. Physical science is learning more and more every day to see in the phenomena of Nature modifications of that one phenomenon (namely, Motion) which is peculiarly under the power of mathematics." Echoes are these, far off and faint perhaps, but still true echoes, in answer to Newton's wish that all these phenomena may some day "be deduced from mechanical principles."

If, turning from this aspect of the subject it were my purpose to enumerate how the same tendency has evinced itself in the Arts, unconsciously it may be to the artists themselves, I might call as witnesses each one in turn with full reliance on the testimony which they would bear. And, having more special reference to mathematics, I might confidently point to the accuracy of measurement, to the truth of curve, which according to modern investigation is the key to the perfection of classic art. I might triumphantly cite not only the architects of all ages, whose art so manifestly rests upon mathematical principles; but I might cite also the literary as well as the artistic remains of the great artists of Cinquecento, both painters and sculptors, in evidence of the geometry and the mechanics which, having been laid at the foundation, appear to have found their way upwards through the superstructure of their works. And in a less ambitious

sphere, but nearer to ourselves in both time and place, I might point with satisfaction to the great school of English constructors of the 18th century in the domestic arts; and remind you that not only the engineer and the architect, but even the cabinet makers devoted half the space of their books to perspective and to the principles whereby solid figures may be delineated on paper, or what is now termed descriptive geometry.

Nor perhaps would the sciences which concern themselves with reasoning and speech, nor the kindred art of music, nor even literature itself, if thoroughly probed, offer fewer points of dependence upon the science of which I am speaking. What, in fact, is logic but that part of universal reasoning; grammar but that part of universal speech; harmony and counterpoint but that part of universal music, "which accurately lays down," and demonstrates (so far as demonstration is possible) precise methods appertaining to each of these arts? And I might even appeal to the common consent which speaks of the mathematical as the pattern form of reasoning and model of a precise style.

Taking, then, precision and exactness as the characteristics which distinguish the mathematical phase of a subject, we are naturally led to expect that the approach to such a phase will be indicated by increasing application of the principle of measurement, and by the importance which is attached to numerical results. And this very necessary condition for progress may, I think, be fairly described as one of the main features of scientific advance in the present day.

If it were my purpose, by descending into the arena of special sciences, to show how the most various investigations alike tend to issue in measurement, and to that extent to assume a mathematical phase, I should be embarrassed by the abundance of instances which might be adduced. I will therefore confine myself to a passing notice of a very few, selecting those which exemplify not only the general tendency, but also the special character of the measurements now particularly required, viz., that of minuteness, and the indirect method by which alone we can at present hope to approach them. An object having a diameter of an 80,000th of an inch is perhaps the smallest of which the microscope could give any well-defined representation; and it is improbable that one of 120,000th of an inch could be singly discerned with the highest powers at our command. But the solar beams and the electric light reveal to us the presence of bodies far smaller than these. And, in the absence of any means of observing them singly, Professor Tyndall has suggested a scale of these minute objects in terms of the lengths of luminiferous waves. To this he was led, not by any attempt at individual measurement, but by taking account of them in the aggregate, and observing the tints which they scatter laterally when clustered in the form of actinic clouds. The small bodies with which experimental Science has recently come into contact are not confined to gaseous molecules, but comprise also complete organisms; and the same philosopher has made a profound study of the momentous influence exerted by these minute organisms in the economy of life. And if, in view of their specific effects, whether deleterious or other, on human life, any qualitative classification, or quantitative estimate be ever possible, it seems that it must be effected by some such method as that indicated above.

Again, to enumerate a few more instances of the measurement of minute quantities, there are the average distances of molecules from one another in various gases and at various pressures; the length of their free path, or range open for their motion without coming into collision; there are movements causing the pressures and differences of pressure under which Mr. Crookes' radiometers execute their wonderful revolutions. There are the excursions of the air while transmitting notes of high pitch, which, through the researches of Lord Rayleigh, appear to be of a diminutiveness altogether unexpected. There are the molecular actions brought into play in the remarkable experiments by Dr. Kerr, who has succeeded, where even Faraday failed, in effecting a visible rotation of the plane of polarisation of light in its passage through electrified dielectries, and on its reflection at the surface of a magnet. To take one more instance, which must be present to the minds of us all, there are the infinitesimal ripples of the vibrating plate in Mr. Graham Bell's most marvellous invention. Of the nodes and ventral segments in the plate of the telephone which actually converts sound into electricity and electricity into sounds, we can at present form no conception. All that can now be said is that the most perfect specimens of Chladni's sand figures on a vibrating plate, or of Kundt's lycopodium heaps in a musical tube, or even Mr. Sedley Taylor's more delicate vortices in the films of the Phoneidoscope, are rough and sketchy compared with these. For notwithstanding the fact that in the movements of the telephone-plate we have actually in our hand the solution of that old world problem, the construction of a speaking machine; yet the characters in which that solution is expressed are too small for our powers of decipherment. In movements such as these we seem to lose sight of the distinction, or perhaps we have unconsciously passed the boundary between massive and molecular motion.

Through the Phonograph we have not only a transformation but a permanent and tangible record of the mechanism of speech. But the differences upon which articulation (apart from loudness, pitch, and quality) depends, appear from the experiments of Fleeming Jenkin and of others to be of microscopic size. The microphone affords another instance of the unexpected value of minute variations—in this case of electric currents; and it is remarkable that the gist of the instrument seems to lie in obtaining and perfecting that which electricians have hitherto most scrupulously avoided, viz., loose contact.

Once more, Mr. De La Rue has brought forward as one of the results derived from his stupendous battery of 10,000 cells, strong evidence for supposing that a voltaic discharge, even when apparently continuous, may still be an intermittent phenomenon; but all that is known of the period of such intermittence is, that it must recur at exceedingly short intervals. And in connection with this subject, it may be added that, whatever be the ultimate explanation of the strange stratification which the voltaic discharge undergoes in rarefied gases, it is clear that the alternate disposition of light and darkness must be dependent on some periodic distribution in space or sequence in time which can at present be dealt with only in a very general way. In the exhausted column we have a vehicle for electricity not constant like an ordinary conductor, but itself modified by the passage of the discharge, and perhaps subject to laws differing materially from those which it obeys at atmospheric pressure. It may also be that some of the features accompanying stratification form a magnified image of phenomena belonging to disruptive discharges in general; and that consequently, so far from expecting among the known facts of the latter any clue to an explanation of the former, we must hope ultimately to find in the former an elucidation of what is at present obscure in the latter. A prudent philosopher usually avoids hazarding any forecast of the practical application of a purely scientific research. But it would seem that the configuration of these striæ might some day prove a very delicate means of estimating low pressures, and perhaps also for effecting some electrical measurements.

Now, it is a curious fact that almost the only small quantities of which we have as yet any actual measurements are the wave lengths of light; and that all others excepting so far as they can be deduced from these, await future determination. In the meantime, when

unable to approach these small quantities individually, the method to which we are obliged to have recourse is, as indicated above, that of averages, whereby, disregarding the circumstances of each particular case, we calculate the average size, the average velocity, the average direction, &c., of a large number of instances. But although this method is based upon experience, and leads to results which may be accepted as substantially true; although it may be applicable to any finite interval of time, or over any finite area of space (that is, for all practical purposes of life), there is no evidence to show that it is so when the dimensions of interval or of area are indefinitely diminished. The truth is that the simplicity of nature which we at present grasp is really the result of infinite complexity; and that below the uniformity there underlies a diversity whose depths we have not yet probed, and whose secret places are still beyond our reach.

The present is not an occasion for multiplying illustrations, but I can hardly omit a passing allusion to one all-important instance of the application of the statistical method. Without its aid social life, or the History of Life and Death, could not be conceived at all, or only in the most superficial manner. Without it we could never attain to any clear ideas of the condition of the Poor, we could never hope for any solid amelioration of their condition or prospects. Without its aid, sanitary measures, and even medicine, would be powerless. Without it, the politician and the philanthropist would alike be wandering over a trackless desert.

It is, however, not so much from the side of Science at large as from that of Mathematics itself, that I desire to speak. I wish from the latter point of view to indicate connections between Mathematics and other subjects, to prove that hers is not after all such a far-off region, nor so undecipherable an alphabet, and to show that even at unlikely spots we may trace under-currents of thought which having issued from a common source fertilise alike the mathematical and the non-mathematical world.

Having this in view, I propose to make the subject of special remark some processes peculiar to Modern Mathematics; and, partly with the object of incidentally removing some current misapprehensions, I have selected for examination three methods in respect of which mathematicians are often thought to have exceeded all reasonable limits of speculation, and to have adopted for unknown purposes an unknown tongue. And it will be my endeavour to show not only that in these very cases our science has not outstepped its own legitimate range, but that even art and literature have unconsciously employed methods similar in principle. The three methods in question are, first, that of Imaginary Quantities; secondly, that of Manifold Space; and thirdly, that of Geometry not according to Euclid.

First it is objected that, abandoning the more cautious methods of ancient mathematicians, we have admitted into our formulæ quantities which by our own showing, and even in our own nomenclature, are imaginary or impossible; nay, more, that out of them we have formed a variety of new algebras to which there is no counterpart whatever in reality; but from which we claim to arrive at possible and certain results.

On this head it is in Dublin, if anywhere, that I may be permitted to speak. For to the fertile imagination of the late Astronomer-Royal for Ireland we are indebted for that marvellous Calculus of Quaterdions, which is only now beginning to be fully understood, and which has not yet received all the applications of which it is doubtless capable. And even although this calculus be not co-extensive with another which almost simultaneously germinated on the Continent, nor with ideas more recently developed in America; yet it must always hold its position as an original discovery, and as a representative of one of the two great groups of generalised algebras (viz., those the squares of whose units are respectively negative unity and zero), the common origin of which must still be marked on our intellectual map as an unknown region. Well do I recollect how in its early days we used to handle the method as a magician's page might try to wield his master's wand, trembling as it were between hope and fear, and hardly knowing whether to trust our own results until they had been submitted to the present and ever-ready counsel of Sir W. R. Hamilton himself.

To fix our ideas, consider the measurement of a line, or the reckoning of time, or the performance of any mathematical operation. A line may be measured in one direction or the opposite; time may be reckoned forward or backward; an operation may be performed or be reversed, it may be done or may be undone; and if having once reversed any of these processes we reverse it a second time, we shall find that we have come back to the original direction of measurement or of reckoning, or to the original kind of operation.

Suppose, however, that at some stage of a calculation our formulæ indicate an alteration in the mode of measurement such that, if the alteration be repeated, a condition of things, not the same as, but the reverse of the original, will be produced. Or suppose that, at a certain stage, our transformations indicate that time is to be reckoned in some manner different from future or past, but still in a way having definite algebraical connexion with time which is gone, and time which is to come. It is clear that in actual experience there is no process to which such measurements correspond. Time has no meaning except as future or past; and the present is but the meeting point of the two. Or, once more, suppose that we are gravely told that all circles pass through the same two imaginary points at an infinite distance, and that every line drawn through one of these points is perpendicular to itself. On hearing the statement, we shall probably whisper, with a smile or a sigh, that we hope it is not true; but that in any case it is a long way off, and perhaps, after all, it does not very much signify. If, however, as mathematicians we are not satisfied to dismiss the question on these terms, we ourselves must admit that we have here reached a definite point of issue. Our science must either give a rational account of the dilemma, or yield the position as no longer tenable.

Special modes of explaining this anomalous state of things have occurred to mathematicians. But, omitting details as unsuited to the present occasion, it will, I think, be sufficient to point out in general terms that a solution of the difficulty is to be found in the fact that the formulæ which give rise to these results are more comprehensive than the signification assigned to them; and when we pass out of the condition of things first contemplated they cannot (as it is obvious they ought not) give us any results intelligible on that basis. But it does not therefore by any means follow that upon a more enlarged basis the formulæ are incapable of interpretation; on the contrary, the difficulty at which we have arrived indicates that there must be some more comprehensive statement of the problem which will include cases impossible in the more limited, but possible in the wider view of the subject.

A very simple instance will illustrate the matter. If from a point outside a circle we draw a straight line to touch the curve, the distance between the starting point of contact has certain geometrical properties. If the starting point be shifted nearer and nearer to the circle the distance in question becomes shorter, and ultimately vanishes. But as soon as the point passes to the interior of the circle the notion of a tangent and distance to the point of contact cease to have any meaning; and the same anomalous condition of things prevails as long as the point remains in the interior. But if the point be shifted still further until it emerges on the other side, the tangent and its properties resume their reality, and are as intelligible as before.

(To be continued.)

THE INVENTION OF THE MICROPHONE

SINCE the name of Sir William Thomson has been imported into the controversy as to the authorship of the microphone, we re-publish the following letter which that gentlemen has addressed to our contemporary, *Nature*.

"THE MICROPHONE.

"The pleasure with which those beautiful discoveries and inventions, the telephone, the phonograph, and the microphone, have been appreciated by the world, has been unhappily, and I must say I think unnecessarily, marred by one of the most disagreeable things that can be thrust on the public—a personal claim of priority, accompanied by accusations of bad faith, especially when made against any one of whose name and fame the public has come to feel concerned.

"Before troubling the public at all with such a matter, Mr. Edison might surely have reasoned out his claim with Mr. Preece, with whom he had been from the beginning in correspondence, or he might have written immediately to public journals, calmly pointing out the close relation between his own 'carbon telephone' and Mr. Hughes' subsequent 'microphone.' The scientific public could then have calmly judged, and would have felt much interest in judging, how much in common, or how much not in common, there may be in the physical principles concerned in the two instruments. But by his violent attack in public journals on Mr. Preece and Mr. Hughes, charging them with 'piracy' and 'plagiarism,' and 'abuse of confidence,' he has rendered it for the time impossible for either them or others to give any consideration whatever to his claims. Nothing can be more unfounded than the accusations! Mr. Preece himself gave, at the Plymouth meeting of the British Association last August, a clear and thoroughly appreciative description of Edison's carbon telephone, and published it in the printed reports of his lecture, which appeared in the public journals. The beautiful results shown since the beginning of the present year by Mr. Hughes with his microphone were described by himself in such a manner as to leave no doubt but that he had worked them out quite independently, and that he had not the slightest intention of appropriating any credit due to Mr. Edison. It does seem to me that the physical principle used by Edison in his carbon telephone and by Hughes in the microphone is one and the same, and that it is the same as that used by M. Clérac, of the French 'Administration des Lignes Télégraphiques,' in the 'variable resistance carbon tubes,' which he had given to Mr. Hughes and others for important practical applications as early as 1866, and that it depends entirely on the fact long ago pointed out by Du Moncel, that increase of pressure between two conductors in contact produces diminution of electric resistance between them.

"I cannot but think that Mr. Edison will see that he has let himself be hurried into an injustice, and that he will therefore not rest until he retracts his accusations of bad faith publicly and amply as he made them.

"WILLIAM THOMSON.

"Yacht 'Lalla Rookh,' Cowes, July 30."

From an article entitled, "Une Querelle a propos du Microphone," by M. A. de Montlambert, which appears in *L'electricité* for July 20, we translate the following instructive passages:—"Before passing to the microphonic arrangement, which is the bone of contention, we would draw the reader's attention to the two following points which, as will be at once seen, ought to be taken into serious consideration. First, the property which certain conductors, and particularly powdered carbon, possess of varying their conductivity with pressure, was known a long time ago. M. Clérac, of the French Telegraph Administration, had applied it in 1866 in constructing a cheap rheostat, formed of a tube filled with plumbago or powdered carbon, in which a piston was moved by a screw. By working the screw, the resistance of the circuit in which the tube was intercalated was considerably increased or diminished. Moreover, M. du Moncel, making, in 1856, some researches on the resistance presented by the contacts of electric keys, or contact breakers, had proved *that the intensity of currents transmitted by their means varied with the degree of pressure exerted between the two pieces in contact.* (See Vol. I., p. 246 of 2nd ed. of M. du Moncel's *Traité des applications de l'electricité*, 1856). Further, he recognised this property in 1872-1876, when making experiments upon the conductivity of divided conductors, and announced it in several memoirs presented to the Academy of Sciences since that time. Lastly, M. Pollard, in constructing a telephone, with a pencil of plumbago, simply leaning against the diaphragm, has shown, in December, 1877, that the variation of conductivity with pressure held equally well for hard carbonised bodies as for those soft charcoals exclusively employed by Mr. Edison. . . . . .

"The claim of Mr. Edison relative to the property possessed by the microphone of serving as a thermoscope proves that he has not at all understood the question. In the first place, Mr. Hughes has never pretended to the invention of a *thermopile*, as Mr. Edison states, but merely to a *thermoscope*, and that thermoscope *is based upon a principle diametrically opposite to that on which the micro-tasimeter of Mr. Edison is founded.* In the latter the effects of heat are indicated by increase of pressure on a disc of carbon, produced by the dilation of a body sensitive to the heat rays which fall upon it. In the apparatus of Mr. Hughes, there are several pieces of carbon enclosed in a quill, and touching each other so lightly as to cause a somewhat unsteady deflection on a sensitive galvanometer, when a current is sent through them. Now, a minute increment of heat has the effect of increasing in a high ratio the resistance of the contacts, and the deflection diminishes in proportion as the heat is increased. This phenomenon has been studied since 1875 by M. du Moncel, who has proved that in middling conductors, of the nature of carbon, pyrolusite (peroxide of manganese), plumbago, and even metal filings, the first effect of heat is to diminish the conductivity of them, but that if they are heated above 100° C., the reverse effect takes place, and the conductivity becomes greater, a fact which he attributed to the dilatation of the particles of the body, which produced an effect analogous to that which would result from an increase of pressure. (See M. du Moncel's Memoir in *Comptes Rendus*,

Nov. 2, 1875). Mr. Edison is therefore mistaken, and this claim of his has no foundation whatever."

The passage from the *Traité des applications de l'electricité* above alluded to, runs thus :—"A very curious fact, and one which appears to be at first sight, in contradiction to the received theory of electricity, is that *the greater* or less pressure between the contact pieces of interrupters, influences considerably the intensity of the current which traverses them. This often results from the studs of the key not being clean, *but it may also be due to a physical cause as yet poorly appreciated.* One thing certain is that with keys, in which the moveable contact piece is urged by an extremely feeble force, the current is often so weak that it fails to effect the electric reaction expected from it."

Apropos of this interesting extract, we (the TELEGRAPHIC JOURNAL) may point out that it is within the experience of all practical electricians and operators that a firm, definite contact is requisite in testing or signalling, to give a steady and good result on a sensitive galvanometer or receiver. A slow and gentle contact is found to influence the current. Soon after hearing of the discovery of the microphone, it occurred to us that the two contacts of an ordinary signalling key might form a more or less sensitive microphone at a certain intensity of the pressure exerted upon them by the hand of the signalling clerk. The researches of M. Du Moncel corroborate this view. If it be correct, the key when in a microphonic state, would transmit microphonically part of the jar or vibration produced by the shock of closing its contacts. We may, therefore, reasonably look for a perturbation in the rise of a current flowing through a key in the act of being closed; and this perturbation will necessarily vary with the mode in which the contacts are produced; a feeble and slow contact causing a different disturbance to that from a smart decided contact. The truth of this supposition might be tested by employing a telephone as the interpreter of the current, as the perturbations will be very delicate. The question is not without its practical importance, since if it be true, the superiority of mechanically effected contacts over hand contacts, in electrical experiments at least, will be apparent; and it is not unlikely that some of those experiments hitherto made on the flow of an electric current into a wire or cable may have to be verified again or corrected.

In an interesting communication to the French Academy of Sciences, M. Du Moncel himself has described the results of his early and later researches on the variation of resistance of contacts and imperfectly conducting bodies under pressure. From this it appears, in addition to the above facts quoted from M. Montalambert, that M. Du Moncel also described in the 1856 edition of his *Exposé*, two kinds of carbon contact breakers for producing undulatory currents. He was led to construct these by the discovery which he made in experimenting with brass, iron, platinum, and carbon conductors, that *the differences of intensity* of the current increased proportionately as the bodies employed increased in desistance. This fact he afterwards (in 1872) remonstrated, when he showed the variations in resistance which wood, charcoal, and coke in a fine state of division could undergo. He then noticed that these subdivided conductors had a *less* or *greater resistance*, according to the more or less bright condition of the metallic particles, and the greater or less degree to which they were concentrated round the electrodes inserted into them.

Touching M. Clérac's researches in 1865, M. Du Moncel also cites the report of M. Zetzsche on the Vienna Exhibition of 1873, published in the *Journal Telegraphique*, for Feburary 25th, 1874 :—"As regards rheostats, the historical part of the exhibition contains, besides the ordinary kinds, graphite rheostats employed since 1865, on intermediate stations to regulate the resistance of the line, &c."

THE MICROPHONE RELAY.

By Profs. EDWIN J. HOUSTON and ELIHU THOMSON, of the Philadelphia Central High School.

IMMEDIATELY after the announcement by Prof. Bell of his remarkable invention of the articulating telephone, we proposed for ourselves the task of relaying this instrument. Quite a number of different arrangements were tried, but, owing to the exceedingly feeble movements of the diaphragm of the receiving telephone, none of them were very successful. The discovery by Prof. Hughes, however, of the inexpressibly delicate microphone, happily afforded us the means of at last solving the problem at which we had been so long engaged.

In our application of the microphone for the relaying of the telephone, we attach a miniature microphone to the plate of the receiving telephone. The microphone so attached consists essentially of three small pieces of carbon, each being about $\frac{3}{8}$ of of an inch in length. These pieces are arranged exactly as in the manner described by Prof. Hughes, viz., one of the pieces of carbon, which is sharpened at both ends, rests vertically in small cavities near the ends of the two other pieces, as shown in fig. 1. The two carbon supports for the third piece are cemented at their ends directly to the plate of the telephone.

The microphone so constructed is placed in the new circuit in which it is desired to repeat the message originally transmitted. The method of its operation is evident. The slight movements of the diaphragm of the receiving telephone, which are, in fact, so slight as to render them almost impossible of detection by mechanical means, are nevertheless at once recognized by the marvellously sensitive microphone, and are repeated in the new circuit as variations in the intensity of the electrical current traversing it. The message so relayed or repeated, for it is evident that the instrument can be used either as a relayer or a repeater, may be either received at once by a telephone placed in said circuit, or may be again repeated in a new circuit. By this means we believe that the distance to which a telephone message can be transmitted will be very greatly increased.

Owing to the extreme sensitiveness of the microphone, it will be necessary, in the practical application of this instrument as a relay, to carefully shield it from all extraneous sounds, which, weak though

they may be, are, nevertheless, very loud when compared with those which would be produced by the feeble movements of the plate of the receiving telephone. This may be obtained in practice in several ways, as, for example, by placing the microphone relay in a box with double or treble hollow walls lined with cotton, wool, or some other non-homogeneous material, or by sinking the instrument in a pit under ground. We have found but little difficulty, however, in the trial of our instrument over a city line of some three miles in length, of obtaining the quiet necessary for the working of the instrument, although the latter was placed in a large room in the second story of a building facing a public thorougfare, and the time of trial was shortly after midday.

slightly inclined. In this position more force is required to move the upright piece, and so cause it to vary the electrical resistance. In all the microphones that we have experimented with when the upright piece was held nearly vertically, whispers or other faint sounds were distinctly transmitted, but the voice of a person standing a few feet from the instrument, and speaking as in ordinary conversation, caused such a rattling of the receiving instrument as either to render the sound unintelligible or greatly confused. In all such cases, a certain inclination could be obtained, varying slightly in each instrument, at which the rattling of the instrument entirely disappeared, and the sound was distinctly and loudly transmitted.

When the microphone relay is placed in a circuit

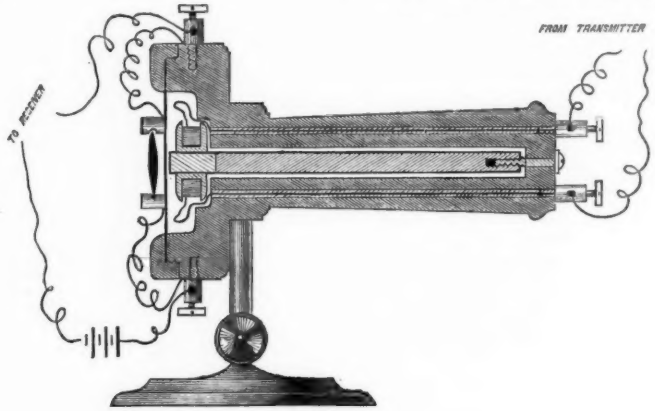


FIG. 1.

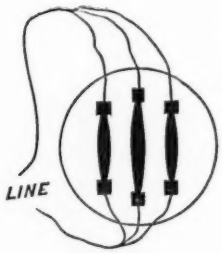


FIG. 2.

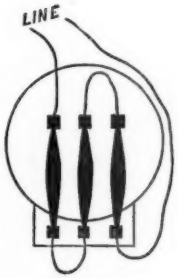


FIG. 3.

The microphone, when properly constructed, has its greatest sensitiveness when the piece of carbon pointed at both ends rests in a nearly vertical position. Its electrical resistance is then at its maximum. In this position the upright carbon is resting on its extreme ends, and the cross-section of contact a minimum. So placed the slightest acoustic movement brings portions of the conical surfaces of the upright piece against the edges of the cavities, and thereby diminishes the resistance by increasing the area of the surfaces in contact. If now it be desired to diminish the sensitiveness of the instrument, it is only necessary that it be so placed that the upright carbon be no longer supported vertically, but be

whose resistance is considerable, as, for example, at the end of a distant station, we increase the sensitiveness of the instrument by attaching a number of minute microphones to the receiving diaphragm, as shown in the figures. These may be connected in series, as in fig. 3, or in multiple arc, as in fig. 2.

Since the variation in the electrical resistance of the microphone depends mainly on the upper contact of the loose piece with its support, an increased delicacy may be obtained by attaching this support directly to the middle of the diaphragm of the receiving instrument, while the lower support need not necessarily be attached to the diaphragm.

We have measured the resistance of a microphone, in which the moveable piece was composed of a piece of carbon about 1¼ inches long and ¼ inch square, and find that when placed in an upright position it has a resistance of about 50 ohms, varying, however, in a marked manner, with any sound. The same instrument, when turned at an angle of about 40° from the vertical, was found to have its resistance diminished to about 25 ohms.

It may be mentioned, as an interesting fact in regard to the microphone, that when the upright piece is placed in the position of its greatest sensitiveness, and a moderately loud sound is made near it, although such sound is only transmitted as a confused rattling, yet its resonance can, in most cases, be distinctly heard. This is probably the cause of the peculiar ringing sound heard when the microphone transmits mere noises, such as those produced by a person walking.

Review.

The Speaking Telephone, Talking Phonograph, and other Novelties. By GEORGE B. PRESCOTT. Fully Illustrated. New York: D. Appleton and Company.

THE object which the author has had in view in preparing this work, as stated in the preface, has been to furnish the public with a clear and accurate description of the more recent and useful improvements in electrical science, and more particularly of the speaking telephone. Mr. Prescott has shown himself thoroughly competent to attain this object, and has produced a work which is a most useful addition to the list of records of the triumphs of electrical science, especially of those won in America. The amount of knowledge of electro-telephony which has been gained may be gathered from the fact that 300 pages in Mr. Prescott's work scarce suffice to deal with the subject. Every pains have evidently been taken to make the information given as complete as possible.

The latter portion of the work deals very fully with quadruplex telegraphy, showing every conceivable modification of the principles involved for working forked circuits, and for "repeating," &c. The ingenious compound-relay of Mr. Gerritt Smith, to which the success of quadruplex telegraphy and its modifications is mainly due, is conspicuous in all these arrangements. The chapter devoted to this subject terminates with a description of the ingenious electro-motograph of Mr. Edison.

A chapter on Call Bells, and another on the Electric Light, in which a considerable amount of useful information is given, concludes the work, which we can heartily recommend to our readers.

Notes.

THE TELEPHONE.—Under the American patents, some 14,000 telephones have, during the past year been installed in the United States, and are being rented at an average rental of £10 per ann.; and fresh orders are being received at the rate of 1,000 sets per month.

WE are glad to observe that a notable reduction in the price and rental of telephones in England has been made by the recently organised Bell Telephone Company, Cannon Street. The former suicidal rates charged for the use of telephones in this country was a matter of regret to all acquainted with the subject. "Make hay while the sun shines" should be the motto of successful inventors; and, as even the telephone may be improved upon or superseded, it was felt that Prof. Bell was losing the harvest which his genius and labour had earned for him. Single telephones for experimental and lecture purposes are now sold at £2 a piece; a pair of domestic telephones with battery, call bell, switch, and 50 yards of wire at £5 10s.; a pair of business telephones with auxiliary apparatus and 100 yards of wire at £7 10s.; mining telephones at £15. Higher styles of telephone than these are charged for at various rates up to £20. There ought to be a wide field for the local use of the telephone in this country, and we are certain that nothing but the high prices hitherto charged for them has stood in the way of their rapid spread.

TELEPHONE CALLS.—In M. Alfred Niaudet's call, the ordinary telephone is transformed into a Reis' make-and-break telephone, by pressing a button in the telephone, and the voice is used to interrupt the circuit. In Mr. E. Conrad Cooke's, a wheel, with a milled rim is turned by hand, and a spring contact rasping on the rim causes an intermittent current to flow through the telephone. Mr. Edison also constructs a call by arranging a pivoted lever with one end resting lightly on the diaphragm of the telephone, so that when an intermittent battery current comes from the other station, the lever will dance up and down on the diaphragm and make a drumming sound. The latest call is that of Mr. A. Le Neve Foster described in the *Journal of the Society of Arts*, August 2nd. It consists of an electro-magnet with a vibrating armature or reed, which makes contact with two opposite contacts alternately like the tongue of a relay; and a local battery and key or press-button. The battery is connected up to the armature on one hand and to one of the sole contacts of the key on the other; the electro-magnet is connected up between the upper armature contact and the line; the lower armature contact is to earth, the lever of the key is to line, and the other sole contact of the key is to the telephone. When the key is at rest the line is to earth through the telephone, and speaking can be carried on by telephone; but by depressing the key, the telephone is disconnected from the line and the call substituted for it. The current from the local battery traverses the electro-magnet by way of the upper contact and the armature, and traverses the line to the distant telephone. The armature vibrates under the attraction of the electro-magnet and interrupts the circuit so as to make the line-current intermittent.

THE Sainte-Etienne Colliery Company of France

have six telephone lines working, the longest extending nearly four miles. Conversation is carried on at the rate of about 100 words per minute. The telephones were made by Brèguet, and cost 12s. 6d. each.

ACCORDING to Chin Hoo, in the Pekin *Gazette*, the telephone, or, "Thumthsein," was invented in China in the year 968 by a philosopher named Kung Foo Whing. This announcement will satisfy the self-complacency of the Celestials without disturbing the equanimity of the western nations. All honour to Kung Foo Whing, whose euphonious name seems made for the telephone.

M. DU MONCEL recently drew the attention of the French Academy of Sciences to the fact, that if any part of the telephone circuit wire be scratched, a feeble grating sound will be heard in the telephones. This sound becomes very marked when those parts of the wire, close to a telephone itself, were scratched. The effect was not merely mechanical for it ceased when the current was interrupted. This peculiar fact throws light on the clamour of confused sounds heard in telephones connected in circuit with ordinary telegraph lines, some of which sounds were evidently not due to induction from the neighbouring lines.

THE MICROPHONE.—*Naturforscher*, the German *Nature*, mentions another inventor of the microphone—a M. Lüdgte—who described a microphone made of two metal plates in contact, a battery and bell telephone, to the Berlin Physical Society in April last. Professor Hughes has evidently won the honours of the discovery "by a neck."

M. DUCRETET has applied the pneumatic tube vibration-transmitter employed by M. Marey in physiological experiments to the microphone. This consists of a flexible india rubber pipe connecting two small drums, or closed air chambers with convex lens-shaped membranes, so that when one of the membranes is pressed against the pulse, the other membrane will pulsate the air transmitted air-vibrations. M. Ducretet makes use of it by resting one of the lens-shaped membranes upon the upper contact of a pencil microphone, leaving the other drum free to be applied to the pulse, the lungs, heart, or other organ of the body. This has been called the *stethoscopic* microphone.

PROFESSOR HUGHES is of opinion that the microphone shows the electric current to be a molecular vibration, which becomes manifest when the molecules of the conductor are free to move by reason of the feeble contact produced under the influence of a very light pressure between two or several parts of the conducting circuit.

MR. EDISON, has we believe, publicly claimed the microphonic repeater, or relay of Professors Houston and Thomson, which we illustrate in this number. He declares it to have been devised by him over a year ago, and published in the *Journal of the Telegraph*, July 15, 1877, and the TELEGRAPHIC JOURNAL about the same time. Mr. Edison doubtless refers to his Pressure Relay. See TELEGRAPHIC JOURNAL, p. 149, Vol. 5, July 1st, 1877.

COUNT DU MONCEL makes a microphone for transmitting speech, of a box lined at one end with zinc and at the other with copper, and containing a layer of fragments of gas carbon steeped in water.

THE microphone is another marvellous invention. By it the faintest sounds are magnified to the dimensions of a thunder-clap. With the microphone a farmer can hear a potato-bug coming down the road a quarter of a mile away, and can go out with an axe and head it off.—*Danbury News*, U.S.

PROFESSOR W. F. BARRETT has pointed out that the term microphone was first used by Sir Charles Wheatstone to designate a mechanical contrivance of his for magnifying small sounds. It is fully described in the *Quarterly Journal of Science*, Part II., 1827.

THE PHONOGRAPH.—In the "Connexion of the Physical Sciences," Mrs. Mary Somerville wrote some forty years ago: "It may be presumed that ultimately the utterence or pronunciation of modern languages will be conveyed not only to the eye, but also to the ear of posterity. Had the ancients possessed the means of transmitting such definite sounds, the civilized world might have responded in sympathetic notes at the distance of many ages." Sir Charles Wheatstone and Sir David Brewster also joined in the expectation, "that before this century is completed, a talking and singing machine will be numbered among the conquests of science."

IN that singular romance, *Contarini Fleming*, Lord Beaconsfield argues at some length that the days of metrical poetry are numbered; that it was a product of the ancient times before the printing press, when poems were sung or recited, not read, and that it would vanish before long after the bards which gave to it birth. Mr. Carlyle and many other eminent writers hold a similar faith. But the phonograph has falsified this doctrine, and the beauty and music of words will still be worth preserving.

THE phonograph has recently created some sensation in new York by repeating before a large audience one of the famous solos of Levy, the cornet-à-piston player. All Levy's most brilliant execution was faithfully reproduced.

PROFESSORS FLEEMING JENKIN and J. E. EWING continue their experiments on vowel sounds by means

of the phonograph. They obtain current curves representing the path of an air particle in sound waves from the phonograph record, by a multiplying lever arrangement and marker similar to that used in Sir William Thomson's Syphon Recorder. Curves of "visible speech" 400 times the size of those imprinted on the phonograph foil are thus obtained. Touching this subject, the *American Journal* for July, gives a full account of an ingenious method of Professor E. W. Blake Brown, University, U.S., for recording articulate vibrations by means of photography.

MR. EDISON has been investigating the constancy of the phonograph marking with a view to reading the record by sight; but although a fundamental form for each syllable or articulated sound doubtless exists, it is difficult to get it freed from what may be called accidental influences. For example, the same sound uttered by different persons gives a different form of indentation, as also does the manner in which it is spoken, or the distance from the diaphragm at which the speaker's mouth is placed, or the force with which it is uttered, or the speed at which the barrel is turned. If the hand be pressed on the cheek while speaking, a different character will be given to the rut in the foil. Vowels are little liable to these variations as compared with consonants.

THE researches now being made by help of the phonograph and phonautograph, into the vibrations of speech, and the visible form of sound waves, should result in a typical or general form, and Mr. J. Munro suggests that phonographic type should be cast of all the phonographic syllables used in speech, so that a phonograph matrix might be composed as a printer's page is now composed. With these phonographic characters there would be no need to speak into a phonograph, and multiply the record by electro-typing (unless individual peculiarities of speech were to be preserved), since the type could be set up mechanically. In this way very powerful phonographs, giving loud articulations of what may be called ideal speech, would be practicable.

THE ELECTRIC LIGHT.—We publish in this number an account of Rapieff's electric lamp.

IT is said that the thirty-four Jablochkoff's electric candles in the Avenue de l'Opera, Paris, are costing £20 per night. The light, however, is more than sufficient for the purpose. Over 300 candles are lit nightly in Paris.

THE different kinds of electric light are now fairly installed at the Paris Exhibition. As many as eighteen different lamps are on view, exclusive of Jablochkoff's candle.

ACCORDING to *L'electricité*, the Paris Gas Company has published in several financial journals an article on the alarm caused by the progress of the electric light, intended to reassure the shareholders of gas companies. The article contests the possibility of substituting the electric light for gas in cities, and concludes that the gas companies run no danger. Energetic efforts are also being made to develope the use of gas for cooking and heating. Meanwhile the splendid lights of Lontin, Siemens, and Jablochkoff steadily burn on, shaming the rows of sickly and feeble gas lights wherever they are seen beside the latter. Even so will truth outshine error, although error be supported by millions. A visit to the Avenue de l'Opera, Paris, just now, is the best possible argument against the inspired article of the Parisian Gas Company.

THE learned Abbé Moigno, director of *Les Mondes*, has suggested to M. Giffard, the English æronaut, the desirability of making several nocturnal ascents in his giant captive balloon at the Paris Exhibition, in order to determine the laws of visibility at a distance by means of an electric lamp placed under the car.

We learn from the *Polytechnic Review*, U.S., that the Telegraphic Supply Company of Cleveland is so crowded with orders for Brush electric light apparatus, for the illumination of mills, depôts, factories, &c., &c., that it has been compelled to run day and night, and is now arranging for a factory four times the capacity of its present one.

AN experimental trial of Lontin's electric light was recently made at the Gaiety Theatre. From the results obtained, there would seem to be good reasons for believing that the expectations of those who have introduced the novelty to the metropolis will be fully realised at no distant date. In order to show that one of the great difficulties in the way of the application of electric lighting—the division of the light—has been surmounted, and that, in fact, the lighting power can be produced at least half a mile from the machinery which forms its source and supply, it is in contemplation to carry the connecting wires from the Gaiety Theatre to Pall Mall.

IT is reported that the Metropolitan Board of Works are seriously meditating the illumination of the Thames Embankment by the electric light. They could not have chosen a better starting ground.

THE joint committee of Her Majesty's Commissioners and of the Society of Arts for promoting visits of selected artizan reporters to the Paris Exhibition have now settled the conditions under which artizans will be sent to Paris. Each artizan is expected to devote from eight to fourteen days to his visit, and pay all his expenses out of a bonus of £8, which will be presented to him. Free admission to the Exhibition will be granted; return tickets, London, Chatham and Dover Railway, for fourteen days, can be obtained at the price of 20s.

Arrangements for getting food and lodging in Paris have also been provided. Besides the artizans selected by the joint committee, artizans may be sent at the expense of their employers or local committees.

A SPECIAL committee of the Society of Telegraph Engineers, including Mr. Latimer Clark, C.E., Mr. Hall, and Mr. C. V. Walker, F.R.S., among its members, has been appointed to devise a standard wire gauge.

AMONG the novelties to be seen at the Paris Exhibition is a series of specimens of electro-plated human brains, sent by Dr. Ore, the ingenious Professor of Physiology at the Bordeaux School of Medicine. Dr. Ore has applied galvano-plasty for purposes of preservation to the brains of men and animals, and has obtained very remarkable results, the external surface presenting the hard brilliant surface of a metal, while the inner substance assumes the consistency of mastic, and is quite unalterable.—*Scientific American.*

GRAY'S harmonic telegraph can now be seen in operation at the Paris Exhibition. It is connected up with the Morse instrument so that the vibratory telephone messages are sent simultaneously with the Morse messages in a manner indicated by Varley in his 1870 patent.

WE hear that a son of Mr. John Pender, M.P., is at Cyprus arranging for the laying of a cable to connect that island with the Eastern Telegraph Company's Mediterranean system.

TWO companies of Royal Engineers from the Southern Division of the Postal Telegraphs, have left in H.M.S. *Simoom* for Cyprus, to erect military telegraph lines there.

THE S.S. *Minia*, of the Anglo-American Cable, has been engaged in removing the Duxbury Cable into water freer from mishaps by fishing boats than its old position.

DURING the last two years the "errors" in messages committed by the Eastern Telegraph Company were only 1,615 words. During three months 561 repetitions were made, which comprised 11,684 words in all, and represented a money value of £3,840.

AS mentioned in the "City Notes" of our last issue, the steamers *Seine* and *Calabria* sent out by the Anglo-American Telegraph Company to repair the 1866 Atlantic Cable, have returned without success. The cable was hooked several times, but the iron sheathing was so rusted that it could not bear the stress of raising the cable to the surface.

A QUICK TELEGRAM.—The Agent-General for South Australia sent a telegram to Adelaide, South Australia, at 3.0 p.m. on Monday, the 22nd ult., from Broad Street, E.C., and received a reply to it at Westminster 18¾ hours after.

IN Parliament, on August 8th, Mr. Anderson asked the Postmaster-General to consider the expediency of adopting a letter or syllable tariff instead of a word tariff, for postal telegrams. The Postmaster-General also announced that an International Telegraphic Congress would be held in London, next June. Mr. Whitwell proposed that the inequality of the rates between telegrams from the Continent to London and telegrams from the Continent to the provinces be removed. Lord John Manners replied that negotiations to that end were now pending between two or three foreign governments.

AN official superior school of telegraphy will commence in Paris, on November 4th. A preliminary examination for the admission of pupils will be held in several of the cities of France, and the final examination will take place on October 21st in Paris. Besides the students of telegraphy in the Ecole Polytechnique, it will be open to postmasters and operators reckoning two years service, to licentiates in science, old pupils of the Ecole Polytechnique, and of the Ecole Normale, Ecole des Mines, Ecole des ponts et Chaussées, Ecoles Forestière, Ecole Centrale des Arts et Manufactures, and there will be a certain number of free students, French or foreign, authorised to attend. A preliminary course, of a year's duration, will be instituted to prepare postmasters and operators for their entrance examination. Passes for admission to the examination should be addressed to the Sous-secretaire d'Etat des Finances before September 1st. Further information can be procured by application to the Central Telegraph Station, Paris, 103, Rue de Grenelle, St. Germain.

A NEW volume entitled *Recueil de Memoires relatifs à la physique des muscles et des nerfs*, has recently been published in Germany by Du bois Raymond. It contains his researches on various subjects, electrical and other, since 1855. To these are added a memoir for the first time published of his observations on the electric phenomena of the *Malapterure* a creature never before investigated in a laboratory.

COBALT PLATING. — An interesting and valuable communication on this subject has recently been made to the French Academy of Sciences. It appears that M. Gaiffe, while studying some of the properties of magnetic metals, obtained by means of the voltaic current, was struck with the superior beauty and hardness of cobalt over iron or nickel, and thought that it might be advantageously utilized in electro-plating if it could be treated as easily as such metals as iron or nickel. Some beautiful samples of the plating on strips and bas-reliefs of red copper were shown to the Academy. The colour is a bright white, resembling old silver. It

is principally for fine-line engraving, such as etching, and for typography that cobalt plating will be useful. It does not oxidize like iron, and it is more durable than either iron or nickel. It is also more easily dissolved in acids, so weak as not to attack copper, whilst nickel can only be readily dissolved in acids which corode copper, so that cobalt may be removed from copper with more facility than nickel. A new plating may thus be substituted for a worn one without injuring the copper basis underneath. The bath employed by M. Gaiffe is a neutral solution of double sulphate of cobalt and ammonia, the mode being a platinum foil, or better a plate of cast or forged cobalt. Cobalt herein differs from iron and nickel, which are not soluble in their baths when pure. To obtain a very regular deposit the article to be plated should be fixed to the electrode of the battery before being immersed in the bath, as without this precaution a marbling is produced on the surface. The deposit is effected almost as rapidly as nickel. M. Edmund Becquerel at a subsequent meeting of the French Academy, pointed out that he and his father had, generally speaking, anticipated the results of M. Gaiffe in a memoir to the Academy in 1862. In this memoir it was also laid down that in order to obtain a coherent deposit, the intensity of the current should be in proportion to the density of the solution to be decomposed. M. Gaiffe recommends an electro-motive force of six volts at the beginning of the operation, diminishing to about three volts towards the end.

New Patents.

2816. "Improvements in magnetising metal or other substances, and utilising same for producing magnetic, telephonic, microphonic, and acoustic effects."—G. E. PRITCHETT. Dated July 13.

2852. "An improved method of communication by means of electrical currents between the passengers and officials in railway trains, and apparatus therefor."—R. W. HAMMOND (communicated by V. von Scheliba). Dated July 17.

2878. "A new or improved electric motor, parts of which are applicable to other electro-magnetic appliances."—E. J. HARLING and R. BULL. Dated July 18.

2929. "Pneumatic domestic signalling apparatus."—J. T. Gent. Dated July 23.

3011. "Improvements in rheophores in commutators and in galvanic batteries connected therewith, particularly applicable to medical purposes."—J. and J. ARNOLD, and J. J. H. Sandy. Dated July 29.

3033. "Improvements in railway switches or points and in the mode of connecting the same with the signals."—E. FELDTMANN (communicated by A. Blanel). Dated July 31.

3040. "Improvements in mechanism or apparatus to be applied to doors, windows, shutters, drawers, and other articles for the purpose of giving an alarm when burglarious or improper attempts are made to open the same."—R. E. N. MASON and J. PRICE. Dated July 31.

3080. "Electric telegraphs."—J. W. BROWN. Dated August 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

4555. "Lighting gas lamps or burners by electricity, &c."—ALEXIS Voisin. Dated December 1, 1877. 2d. A platinum wire, heated by an electric current from a battery, is made to ignite the gas. The turning of the gas cock lets on both gas and current. (*Not proceeded with.*)

4608. "Apparatus for repeating voice sounds by electricity."—CAPT. M. T. SALE, R. E. Dated December 5, 1877. 4d. This describes a telephone, consisting of a vibrating membrane fitted with a platinum contact stud at its centre. This stud is opposite an adjustable screw contact; a battery is connected in circuit with the diaphragm contact, the screw contact, and the line. A drop of conducting liquid or a flame completes the circuit between the contacts. The vibrations of the voice impart their motion to the diaphragm, which varies the resistance of the fluid contact, and sends wave currents into the line. (*Not proceeded with.*)

4685. "Telephones."—CARL HEINRICH SIEMENS (communicated by Dr. E. Werner Siemens, Berlin). Dated December 10, 1877. This consists in overcoming the straining of the diaphragm of a telephone out of its natural position under the attraction of the one electro-magnet adjacent to it, by placing the diaphragm between two electro-magnets. For this purpose, according to one construction, the iron diaphragm is fixed in a circular box, each side of which is a permanently magnetic disc. At the centre of one of these discs there is a core, surrounded by a coil. The other disc on the opposite side of the diaphragm has a hole in its centre for the passage of the sound waves. This disc being opposite to the other disc and core, the iron diaphragm rests between the two in equilibrium, without being strained more in one direction than in the other. Instead of an iron diaphragm, a non-metallic one may be employed, having a light annular coil of aluminium on its face, vibrating with it in a magnetic field formed of the annular space between a magnetic core and a surrounding tubular magnetic disc. Bells or tuning-forks may be employed in lieu of diaphragms so as to transmit bell or other tones.

4706. "Voltaic medicated plaster."—WARREN BAILEY POTTER, Boston, Mass., U. S. Dated December 11, 1877. 6d. This consists in forming these plasters so that the plaster shall lie between the skin and the strips of zinc and copper forming the voltaic arrangement. Holes are punched through the plaster exposing portions of the plates, which are connected in series by strips of cloth.

4748. "Magneto-electric Machines."—E. WESTON, New York, U.S. Dated December 14, 1877. 6d. This consists in improvements in Weston's machine, described in a prior patent, No. 4280, of 1876. These are the combination with a commutator of two brushes attached to a pivoted disc, whose axis coincides with the axis of the commutator shaft, the disc being provided with one or more set screws, whereby it may be clamped in variable positions, for the purpose of regulating the strength of the current. Also a device for automatically closing and breaking the circuit, by means of a disc attached to a shaft, which has its bearing in the end of a pillar, and is rotated by means of a belt from the shaft of the machine. The disc contains two radial slots, each of which contains a sliding switch block, which is pressed inward toward the axis of the disc by an adjustable spiral spring. These blocks rest against a metal hub, when they yield to the action of the springs. When the speed of the machine falls below a certain rate, the switch blocks form an electrical contact with the hub, and the current from the machine is short circuited. On the contrary, when the desired rate of speed is attained, the current is sent through the line into the electro-typing vats, &c.

4803. "Metallic cement for galvanic batteries." M. F. ROBERTS. Dated December 17, 1877. 2d. This con-

sists in forming the zinc pole of cells of a solid alloy of zinc and mercury, in preference to amalgamating it. The alloy is formed by running together say, 7 parts of molten zinc and 1 part of an alloy of equal quantities of zinc and mercury. (*Not proceeded with.*)

4824. "Insulating telegraph wires, &c." BRISTOW HUNT (communicated by D. Brooks, Philadelphia, U.S.) Dated December 19, 1877. 6d. This consists in covering wires with cotton, heating it to 300° to 320° Fah. for 1½ hours, to expel the moisture and gases from the fibres, and then plunging it into melted paraffine or paraffine oil. Wires and cables so prepared are introduced into iron pipes while both pipe and cable are at the above temperatures. These pipes are in convenient lengths for laying from barges or waggons.

4847. "Telephonic apparatus." CHARLES AMBROSE MCEVOY. Dated December 20, 1877. 6d. This consists in making one telephone serve for sending and receiving at each end of a line. A pipe leading out from the chamber in rear of the metal diaphragm, which chamber is made deeper than usual, is provided at its extremity with a small trumpet mouth, into which the message to be sent is spoken. This pipe is provided with elbow bends, so that when the diaphragm is held in the ordinary way close to the ear of the listener, the mouthpiece may be just in front of his mouth; or the tube may be long and flexible.

Correspondence.

LIEUT. H. P. KNIGHT. — The manufacturers of De la Rue's cell as described are Messrs. Latimer Clark, Muirhead & Company, 29, Regency Street, Westminster. The price is, we believe, about 2s. per cell. We have personally seen this cell at work for months, and can testify to its merits. To our knowledge a set of twenty were used daily in cable-testing for six months without having shown any unsteadiness or loss of power. It must, therefore, be considered lasting as well as constant, economic, cleanly, and portable. Care should be taken to prevent the evaporation of the liquid in a hot climate like that of Malta.—ED. TEL. JOUR.

General Science Columns.

THE TOTAL ECLIPSE OF THE SUN which was visible over a belt of the south-western territories of the United States from Montana to Texas, on July 29, was well observed at all the different stations selected by astronomers. There are many indications of a remarkable change having taken place in the corona since 1871. Mr. Norman Lockyer telegraphs that the corona is found to change with the sun-spots. Professor Watson has discovered a new body of four and a half magnitudes, near the sun.

WE learn from *Nature* that Professor Tait is developing a very loud and economic fog signal, giving a noise similar to that of the drum, which is one of the most economical of sound alarms.

A NEW compressed-air fog signal has been erected on Cape Spear, Newfoundland. The blast will sound for seven seconds, once a minute, and will range from one and a half to ten miles, according to the state of the atmosphere.

A BED of fine lithographic stone has been discovered near Oran, in Algeria.

TASMANIAN TIN.—Tasmania is rapidly becoming a second Cornwall in the quality and extent of its tin supplies. Four years since, the value of tin and tin-ore exported from the colony was barely £7,000, while in 1877, the value of the tin exported was nearly £27,000. Until recently, the principal portion of the tin in Tasmania was obtained by the ancient process of "streaming," or washing the sand and earth in water, and allowing the heavier metallic parts to subside; but by the discovery of lodes at Mount Bischoff, the colonial miner has been enabled to compete on equal terms with his fellow craftsman in Cornwall. The mining district of Mount Bischoff has now found a rival in a tin mountain at Mount Humskirk, on the west coast. The "wash dirt" is some twenty feet thick, and produces about twenty-five per cent. of tin; but the existence of solid seams of the metal, traversing the mountains in veins several feet in depth and width, has thrown even these productive workings into the shade. Some "nuggets," weighing several cwts. each, have been found, yielding nearly cent. per cent. of pure tin. Mixed with the tin, too, is a small quantity of gold, which adds considerably to the tin miner's profit.—*Engineering.*

THE FRENCH METEOROLOGICAL SERVICE. — This service, founded by Leverrier, has just been separated from the Observatory of Paris, by a decree, dated May 14, 1878, and will soon be localised in a separate central bureau. It comprises the study of the movements of the atmosphere, meteorological warnings to ports and farmers, the organising of meteorological stations, and publication of useful data. The director is M. Mascart, professor in the College of France. The *Bulletin Internationale*, of the Observatory of Paris, will be the organ of the service, and will contain a synoptrical chart of barometric pressures, indicating also the wind, and the state of sky and sea; a chart of temperature, containing also the rainfall of the preceding day, and the storms signalled by despatches; the general condition of the day; warnings to sea-ports and agriculturists, and the observations made at Paris. A supplement will give the daily observations made during every month in the country and abroad. The reports from all Europe are centralised each day at Paris, and immediately utilised in order to transmit telegraphic warnings throughout the land. Among the names of the members recently appointed for three years to superintend the service, we notice those of M. Berthelot, M. I., who represents the Ministry of Public Instruction, and M. Blavier, telegraph engineer of the Government, to represent the French Postal Telegraph Administration.

City Notes.

Old Broad Street, August 14th, 1878.

AT the half-yearly meeting of the Anglo-American Company, Viscount Monck waxed jubilant at the cessation of "futile competition;" the same phrase was in the mouth of the chairman of the Direct United States Cable Company the same day. Thus the chairmen of both companies appear to be well satisfied that the amalgamation has already been fraught with benefit to each concern. There is one remark of Lord Monck's which deserves a word of entire praise. The noble chairman of the Anglo-American Company said at the meeting over which he presided, that he thought the state of their receipts, even under the present circumstances, bore out his opinion that there was room enough in the Atlantic for both the Direct and the Anglo Companies to make a good profit. Exactly; there is more than room enough. There is room enough in the Atlantic for another company to make a good profit. There might be room enough in the Atlantic for the Anglo-American and Direct Companies after a new company was formed, but they would have to reduce their tariff if they wished to make anything like good receipts. The sanguine anticipations of Lord Monck would be appropriate and safe if there did not exist the remotest chance that a rival company might, one fine morning, commence business. But surely Lord Monck cannot really imagine that the field of enterprise in which the shareholders of the Anglo-American Company are specially interested will never be invaded. Does he honestly believe that no capitalist, or body of capitalists, will ever dream of disturbing a system of monopoly which presses heavily upon all who have to use the American cables? Apart from the circumstance that the bright hopes of their chairman may be rudely dissipated at any moment, the shareholders of the Anglo Company, as we said in our last, have no particular reason to feel anxious. If their receipts are less than last half-year, is not the expenditure more? Is not the dividend the same as last year? Have not the directors agreed to spend £12,000 to £14,000 in order to increase the efficiency of the company's cables? No; it is clear, at any rate, that amalgamation has not proved the ruin of the Anglo-American Company. It was not intended to prove its salvation, was it? We forget.

But what of the Direct Company? "So long as they charged moderate rates," observed the chairman, "and reduced rates to the Press and the Government they would progress;" and he points triumphantly to the sum which has been added to the reserve fund. But £32,000 is not an immense sum, considering that there is no increase in the dividend. Mr. Pender was not at one time so easily pleased. Perhaps he looks more to "a great impulse of trade" for augmenting the company's receipts. We sincerely hope he does not look in vain; but now optimists who imagined that Peace would make all things right are beginning to doubt—in the face of the last revenue returns—whether trade will revive as they anticipated.

We must confess, however, we are surprised at the silence which was maintained, no less at the meeting of the Direct, than at that of the Anglo-American Company. Shareholders must, of course, be left to look after their own affairs, and if they are unwilling to raise a voice in their own defence, directors are justified in assuming that they have their full confidence.

As everything was smooth at the meetings of the Anglo-American and the Direct Companies, it followed that no storm ruffled the serenity of the proceedings at the subsequent meeting of the shareholders of the Globe Telegraph and Trust Company. The chairman read the report: remarked that the investments showed little change; that a dividend had actually been paid; that the value of Atlantic stock, and of their own shares, had improved; that their receipts had been augmented; that their expenses were a trifle higher—increase of receipts, and the payment of a dividend entailing inevitable and growing expense; that the revenue next year would be still greater; and that, finally, the prospects of Globe shareholders were pretty well all that could be desired. Having finished his speech, the chairman proposed the adoption of the report. It was seconded, and, after "a very brief discussion," carried, and the usual vote of thanks to the chairman and directors terminated the meeting. Our readers know what we think about the Globe Company. We have nothing to add to, or take from, what we deemed it necessary to say many months ago. We have only one remark to make in reference to the chairman's speech at the meeting. He has, at any rate, the courage of his convictions. He properly credited the Globe Company with bringing about "a working arrangement between the Atlantic Companies." We think we have given the Globe Company credit for the same thing. But the chairman added, "instead of leaving them (the Atlantic Companies) to do, by hostile competition, private rebates, and commissions, as much injury as possible to each other." Well, that is one way of looking at the matter—the way of a gentleman who has a considerable interest in the Globe Trust.

It is satisfactory to learn that the directors of the India Rubber, Gutta Percha, and Telegraph Works Company (Limited) are carrying forward as rapidly as possible the legal formalities necessary for the readjustment of the company's capital. Meanwhile, we find that the profit for the six months ending June 30, after charging all expenses and depreciations and providing for bad debts, is £23,494, making, in addition to the £21,055 brought forward from last year, a total balance in profit and loss account of £44,549. The directors recommend a distribution of an *interim* dividend for the half-year, payable on the 16th instant, of 25s. per £50 share, free of income-tax, being at the rate of 5 per cent. per annum. This will require £11,750, and the remainder of the balance is to be carried forward.

An extraordinary and important meeting of the shareholders of the Eastern Telegraph Company was held on the 9th instant in order to consider a proposal of the directors for the acquisition of the cable of the Black Sea Telegraph Company, the directors having in view the connection of the island of Cyprus with the existing lines of the company. The chairman of the Eastern Company warmly advocated the acquisition, and also the extension to Cyprus, and eventually moved a resolution approving the raising of what is estimated as sufficient money by the issue of debentures to the extent of £250,000. It was explained that the extension would cost £23,000 less than this sum, but the £23,000 would be devoted to surplus cable and stores. The debentures to be issued at five per cent. and to be offered *pro rata* to the shareholders. We are not surprised that the scheme was opposed, and we are bound to agree with the dissentients that the extension to Cyprus is rather unlikely to prove remunerative.

An extraordinary general meeting of the Indo-European Company is to be held on Friday week in order to consider, and possibly approve and authorise, the carrying out of a co-operative working agreement between the Indo-European Telegraph Department of Her Majesty's Indian Government, the Eastern Telegraph Company (Limited), and the Indo-European Company itself, relative to the division between the

three administrations of the revenue derived from the transmission of Indian and Trans-Indian messages. The meeting will also be empowered to pass such resolution or resolutions in regard thereto as may be approved.

The directors of the Cuba Submarine Telegraph Company report that the gross revenue for the six months ending 30th June last, including the balance brought forward from the last account, amounts to £18,278, and the expenditure to £15,920, leaving a net profit of £2,358. The unusually large expenditure arises entirely from the cost of the repair of the Cienfuegos-Santiago section of the original cable, amounting to £12,602, 4s. 2d., the ordinary expenses—amounting to £3,317—being rather less than usual. Considering that in the repair the cable has been renewed to the extent of 51½ knots, the directors think they are warranted in charging the sum of £5,575 to the reserve fund. This sum, added to the balance of revenue account, will admit, after providing for the preference dividend, of a dividend on the ordinary shares at the rate of 6 per cent. per annum, leaving the sum of £133 to be carried forward to the current half-year's account, and they recommend that dividends be declared accordingly, payable 20th proximo.

Notice is given that the forty-second ordinary half-yearly general meeting of the Mediterranean Extension Telegraph Company, Limited, will be held at the City Terminus Hotel, on Wednesday, the 21st August, at twelve o'clock precisely, for the transaction of such business as shall be brought before it, including the declaration of a dividend, the election of two directors in the place of Sir J. R. Carmichael, Bart., chairman, and the Hon. Ashley Ponsonby, who retire by rotation, and of the Auditor, Mr. Allwright, who all being eligible, offer themselves for re-election. The Transfer Books will be closed from the 13th to the 21st inst., both inclusive.

The following are the latest quotations of telegraphs: Anglo-American, Limited, 61¼-61⅜; Ditto, Preferred, 90-91; Ditto, Deferred, 34¼-34⅜; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅝-6⅞; Cuba, Limited, 9½-9¾; Cuba, Limited, 10 per cent. Preference, 16⅞-17½; Direct Spanish, Limited, 1-1⅛; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13⅜-13⅞; Eastern, Limited, 7⅛-7¼; Eastern, 6 per cent. Debentures repayable October 1883, 107-110; Eastern 5 per cent. Debentures repayable August, 1887, 101-102 xd.; Eastern 6 per cent. Preference, 11⅛-11¼; Eastern Extension, Australasian and China, Limited, 7⅛-7⅜; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109 xd.; German Union Telegraph and Trust, 8¼-8⅜; Globe Telegraph and Trust, Limited, 5¼-5⅜; Globe 6 per cent. Preference, 10¾-11; Great Northern, 8⅜-8½; Indo-European, Limited, 20¼-21½; Mediterranean Extension, Limited, 3-3⅛; Mediterranean Extension, 8 per cent. Preference, 9¾-10¼; Reuter's Limited, 10-11; Submarine, 228-233; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2¼-2½; Ditto, 6 per cent. First Preference, 8¼-9; Ditto, ditto, Second Preference, 8¼-8⅜; Western and Brazilian, Limited; 4½-4⅝; Ditto, 6 per cent. Debentures "A," 94-97 xd., Ditto, ditto, ditto, "B," 92-95 xd.; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds, 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30¼-31; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2¾-3; India-Rubber and Gutta-Percha and Telegraph Works, Limited, 31-32.

As we expected, the speculators who were responsible for the "enthusiasm" which prevailed at a certain memorable meeting of Chatham and Dover shareholders and their friends, are now trying their hardest to get up another agitation, having for its object the carrying out of the dropped "fusion" scheme. But the shareholders of the South Eastern Company, at any rate, cannot be induced to take any interest in the matter. It will serve the persons right who forced up Chatham stock to a high price if they find their operations to have told against themselves. It is almost inconceivable that there should exist dupes who will be misled by this last impudent attempt to bamboozle the investing public.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
July, 1878 ...	43,610	11,759	2,800	812	14,540	34,451	24,927	18,811	... ...	10,705	... ...	... ...	4,438
July, 1877 ...	38,790	9,329	2,954	823	14,820	42,713	22,224	19,187	... ...	9,943	1,925	7,883	4,980
Increase	4,820	2,430	... ...	... ...	... ...	... ...	2,703	... ...	... ...	762	... ...	... ...	... ...
Decrease	... ...	... ...	154	11	280	8,262	... ...	376	... ...	... ...	... ...	... ...	542

* Estimated. *h* Not yet published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).